

A WORLD OF BECOMING

Eleven Original Compositions, with Analytical Notes, by Ian Shanahan.

IAN LESLIE SHANAHAN

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A World of Becoming is gratefully and wholeheartedly dedicated to the memory of my former professor – a superlative musician, thinker, and educator:

EMERITUS PROFESSOR PETER PLATT.

(Were it not for him, I would now be incarcerated in Long Bay Jail.)

ABSTRACT

The Platonist expression 'World of Becoming' signifies a physical manifestation, in time and space, of abstract ideas and archetypes from the metaphysical 'World of Being' – an absolute eternal realm, beyond space-time. All human art-forms therefore belong to our 'World of Becoming'. Yet music – arguably the least tangible of the arts – is capable of bridging these two 'Worlds'. The series of compositions herein represent increasingly sophisticated attempts to build such a bridge.

Composing music is intended, ultimately, to be a search for *unity*. As the sequence of eleven pieces unfolds within **A World of Becoming**, it will become apparent that *multilevel architectonic self-similarity* reconciles seemingly heterogeneous forms into a unified whole. Self-similarity proves to be an efficacious tool for designing multidimensional, life-like sonic objects – unified holistic organisms – whose structural and acoustic richness begins to approach that of the Cosmos itself. The result is a 'Natural music' – in the Boethian category *musica mundana* – which could even be a true *musica humana*, a mystical music that affirms diversity embraced in *unity* – *rapprochement* and interreferentiality in deep conceptual abstraction, beyond superficial, fictitious dualisms.

Besides *self-similarity*, some of the principles and strategies resident in the author's works that achieve such unity – and imbue the music with meaning – are: *number*, *pattern* and *proportion* (from Sacred Geometry and *gematria*); *systematic permutation* (elements of self-contained autopoietic Cyclic Groups); *broken symmetry*; *metaphor* and *acoustical symbolism*. As abstract ideas, they comprise the mechanisms for spanning the sensual and noumenal domains. Prior to the scores exhibited within each chapter, further explication of these ideas shall be provided through analytical notes – 'snapshots' that discuss the compositional techniques therein. The Appendices include two published texts which outline the author's evolving aesthetic stance, as an artist who has been creating new music throughout the last two decades of the twentieth century.

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Although, in its final documented form, **A World of Becoming** is ‘merely’ an aggregation of eleven composition manuscripts, an exordium, analytical notes and sundry recordings (flanked by other supporting materials), a moment’s reflection will surely reveal that such an undertaking could not have been carried out at all without the encouragement and support of many people and institutions. To all of those helpers who have assisted me somehow in the formulation of this work, I express my deepest gratitude.

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Kathleen Gallagher and Mark McGregor {**Dimensiones Paradisi**}.

Ian Shanahan, Sydney, August 2001.

PITCH DESIGNATION

For any textual references to pitch throughout **A World of Becoming**, “Middle C” [MIDI note number 60] shall be designated as $C_{\flat}3$, the C_{\flat} one octave higher as $C_{\flat}4$, and the C_{\flat} one octave lower as $C_{\flat}2$, etc. (i.e. assuming that $A_{\flat}3 = 440$ Hz, then $C_{\flat}3 \approx 261.6255653$ Hz). Within this frame, then, quartertones – i.e. 24-tone equal-tempered intervals – and other microtones are specified as follows:

1. \sharp denotes a pitch one quartertone higher than \flat ;
2. \downarrow denotes a pitch one quartertone lower than \flat ;
3. Smaller degrees of intonational deviation – i.e. slight microtonal inflections (not necessarily tempered), of up to about an eighthtone – upwards and downwards are indicated by upward-pointing and downward-pointing arrowheads, respectively, upon accidental symbols.

Examples: $B_{\downarrow}5$; $F_{\sharp}4$; $A_{\flat}3$; $G_{\downarrow}2$; $C_{\sharp}1$; $D_{\flat}6$; $E_{\downarrow}3$; $C_{\sharp}0$; $F_{\downarrow}5$; etc.

(Note finally that three-quartertone accidentals are *never* employed anywhere within **A World of Becoming**.)

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A World of Becoming

CHAPTER 1. EXORDIUM

*“... numbers are the thoughts of God ...
The Divine Wisdom is reflected in the numbers impressed on all things ...
the construction of the physical and moral world alike is based on eternal numbers.”*

– St Augustine of Hippo (AD 354–430).¹

1.1 AESTHETIC AND PHILOSOPHICAL FOUNDATIONS

*“... the true reading of $E = Mc^2$ should be,
‘Evolution is equal to Man multiplied by the speed of concept raised to the second power’.”*

– Alfred Bester: **The Deceivers**, p.303.¹

During the Spring of 1999, while savouring Peter Sculthorpe’s autobiography **Sun Music: Journeys and Reflections from a Composer’s Life** and the incisive **Music Ho! – A Study of Music in Decline** by Constant Lambert (together with several other writings on music),² somewhere therein I read about that spirited dialogue between those supreme symphonists Gustav Mahler and Jean Sibelius, in which these two gentlemen were jousting over the territory of the symphonic form. For Mahler the symphony was an all-inclusive Universe, one able to encompass many kinds of opposites, regardless of form; Sibelius, on the other hand, saw the symphonic genre as a network of pure structural relationships – a unified grid in which musical content was essentially subordinate to (albeit the articulator of) one’s formal scheme. Had I – a futuristic third party who hails from the Antipodes – been privy to their conversation, I would have told each of these eminent composers that for my own music, I long to embody both of their ideals: to reconcile (through abstract means) all apparent diversities, embracing them in a harmoniously integrated soniCosmos where ‘structure’ and ‘content’ dissolve into one another mutually ... to blossom within a deeper holistic globalism. This postulate – the synthesizing of transcendent *unity* – is my basic creative thesis in **A World of Becoming**.

In 1981, as an undergraduate student-composer, I asked myself a question that has stayed with me ever since: how might music (without any accompanying verbal text) possess *meaning*? Over the years, one answer in particular – that meaning can proceed from number and proportionality, in imitation of nature and beyond – has percolated slowly through my consciousness to occupy in my mind a position of prime philosophical and compositional importance. Why, then, does number deserve such an elevated status

within the imagination? Numbers can be a catalyst to reify the noumenal; their very abstraction signifies that numbers are not merely part of (or may even find proper representation in) the World of Phenomena but instead transcend it, comprising a bridge that links the eternal, archetypal 'World of Being' to our Universe. For instance, a well-structured piece of music's vibrational building-blocks – its sounds – tickle the senses, and thus are truly rooted in our hylic 'World of Becoming'; but such a composition's geometric ground-plan, as well as its intervallic relationships, substantialize number (which is itself petrified eternally in transcendent Being). Music is therefore capable of spanning these two 'Worlds'.

Although the issue has been hotly contested for centuries by philosophers and mathematicians, the efficacious existence of number is in no way contingent upon nature's physicality – let alone human culture.³ The classical Pythagorean-Platonic stance (which I do insist remains true, notwithstanding an entrenched worldwide sycophancy towards postmodernity and its aberrant relativisms)⁴ is that Eternal Number constitutes, or abides with, absolute reality; number, though quintessentially supramundane, nonetheless underlies nature – and is also the key for exploring it:

In the writings of the old philosophers there is common agreement that the true purpose of number is for investigating the universe. Traditional cosmogonies tell how the Creator dreamt up a scheme of number, and from that original thought everything else proceeded. From the dance of the atoms to the revolutions of the planets every type of growth and motion is governed by the same set of laws, which are the laws of arithmetic. Number was therefore called 'the first paradigm', the primary reflection of reality. The orthodox view of the matter was stated by Nicomachus of Gerasa in the first or second century AD. Nature [i.e. the Cosmos], he says,

has been determined and ordered in accordance with number, by the forethought and the mind of him that created all things; for the pattern was fixed, like a preliminary sketch, by the domination of number pre-existent in the mind of the world-creating God, number conceptual only and immaterial in every way, but at the same time the true and eternal essence, so that with reference to it, as to an artist's plan, should be created all these things: time, motions, the heavens, the stars and all kinds of revolutions. . . .

[Number] existed before everything else in the mind of the creating God, like some universal and exemplary plan, relying upon which as a design and archetypal example the Creator of the universe sets in order his material creations and makes them attend to their proper ends. (**Introduction to Arithmetic**, I, 6 & 4.)

In their cosmological inquiries the ancients paid less attention to physical phenomena than to the study of number. In the fixed ratios of arithmetic they discerned a constant reality ('that which always is and never becomes') as distinct from the apparent but illusory world of phenomena ('that which is always becoming but never is'). ...⁵

Nevertheless, for millennia, pensive human beings have sought to detect and to impose order upon our wayward Universe – to render it explicable and docile by striving to codify *all* of its behaviours – through the formulation of abstract precepts that map well (as

predictive tools) onto the natural world. One archaic, traditional mechanism behind such a scientific bridge is analogy, or *analogia*:

The concept of *analogia* comes from Greek mathematics, but the use of analogies or proportions is much older. The musical use of analogy is seen in the modular construction of scales and metres as well as the Pythagorean-Platonic world-view, which was modelled on the integral ratios and, possibly also, on the irrational temperaments of musical tuning. The limitations of analogy are revealed by the existence of anomalies, such as the impossibility of tuning an entirely regular scale by integral ratios. ...⁶

We owe the term 'analogy' to the ancient Greek mathematicians who developed the first known theory of exact proportions. Starting from the concept of *logos* as number and ratio, they defined *analogia* as similarity or identity of ratio, as in $A:B = B:C$ (continuous proportion) or $A:B = C:D$ (discontinuous proportion). The theory of proportion or analogy was elaborated between the times of Pythagoras and Plato, when arithmetic and geometry were closely aligned with cosmological speculation and music theory; but the practical use of proportion is much older than the Greeks. The monumental art of the Egyptians and Babylonians was clearly controlled by some system of proportions; and evidence of proportional design, evidently based on the canons of the human hand and foot, has been found at Çatal Hüyük (in modern Turkey), one of the oldest towns in the world. Here the rooms of houses dating from the seventh and sixth millennia BC have been reported as 'commonly averaging 20 by 15 feet' – though it might be somewhat premature to describe this harmonious proportion as *diatessaron*! ...⁷

But, in a thoroughly Gödelian twist,⁸ certain natural anomalies that could not be harmonized into any prevailing cosmology soon exposed themselves. Within our Cosmos, alongside of those things which conform straightforwardly to known mathematical laws, there exist refractory phenomena that cannot be nicely ratiocinated into an orderly analogical paradigm:

... [However, long] before the Greeks it was discovered that the pursuit of analogy often ends with the recognition of anomaly [*anomalía*]. The observation of diurnal, monthly and annual analogies made the calendar possible; but the anomalous cycles of the sun and moon made it impossible to construct an harmonious calendar: our tempered calendar of twelve notional months is a musical approximation. Perhaps the most famous anomaly to be discovered by the ancients was the lack of 'symmetry' or common [commensurable] measure between the equal sides and the hypotenuse of the right-angled isosceles triangle. ... [This anomaly] showed ... that the world could not be entirely reduced to a common arithmetical measure and that analogies did not always involve rational numbers. ... The extant classical writings on music ... reveal a persistent concern with the proportions of tuning and temperament, particularly with the anomalous fact that a perfectly tuned scale cannot be constructed solely from simple numbers or small-number ratios. Because of a natural discrepancy between the series of octaves generated by the ratio 1:2 and the series of fifths generated by the ratio 2:3, the cycle of twelve fifths does not quite return to its starting point at the seventh octave. ... Having tried to create a musical world-view – one of the oldest metaphysics – based on the proportions generated by the first ten integers, the Greeks were forced to recognise [such] embarrassing anomalies, ... Thus the simple, harmonious analogies of the 'fixed' notes of the scale – octave, fifth and fourth – led inexorably, by the same mathematics, to the anomalies of the 'moveable' notes, those smaller intervals whose proportions cannot be entirely

rational. ...⁹

And yet, just as the Cosmos itself enfolds both *analogia* and *anomalía* in a higher harmonious globality (whereby ‘order’ and ‘chaos’ are compossible with one another),¹⁰ so too can apparently disparate musical objects be unified somehow within a single composition:

... [Art can] imitate nature not only in the ... analogies of rational geometry but also in the unpredictable anomalies of irrational expression and spontaneous behaviour.¹¹

For the unification of antitheses becomes viable whenever one discerns them appropriately – as facets of some loftier, more elusive model. The Pythagoreans’ arithmetical quandary over *arrheton* (incommensurable quantities – ‘irrationals’ – that can never be expressed fractionally, as ratios of whole numbers)¹² was later resolved through recognizing the givenness and potency of ‘real numbers’, that marvellous infinite set – indeed, a ‘field’ – which incorporates both rational and irrational values, as subsets. Likewise, we are now seeing in emergent Western sciences a reconciliation of ‘order’ and chaotic ‘flux’; these contrarities may well prove to be interdependently propagative:

For a good many centuries, human thought about nature has swung between two opposing points of view. According to one view [which upholds ‘order’: *analogia*], the universe obeys fixed, immutable laws, and everything exists in a well-defined objective reality. The opposing view [characterized as ‘chaos’: *anomalía*] is that there is no such thing as objective reality; that all is flux, all is change. As the Greek philosopher Heraclitus put it, “You can’t step into the same river twice”. The rise of science has largely been governed by the first viewpoint. But there are increasing signs that the prevailing cultural background is starting to switch to the second – ways of thinking as diverse as postmodernism, cyberpunk, and chaos theory all blur the alleged objectiveness of reality and reopen the ageless debate about rigid laws and flexible change. ... We need to find a way to step back from these opposing worldviews – not so much to seek a synthesis as to see them both as two shadows of some higher order of reality – shadows that are different only because the higher order is being seen from two different directions. But does such a higher order exist, and if so, is it accessible? To many – especially scientists – Isaac Newton represents the triumph of rationality over mysticism. The famous economist John Maynard Keynes, in his essay **Newton, the Man**, saw things differently:

In the eighteenth century and since, Newton came to be thought of as the first and greatest of the modern age of scientists, a rationalist, one who taught us to think on the lines of cold and untinctured reason. I do not see him in this light. I do not think that anyone who has pored over the contents of that box which he packed up when he finally left Cambridge in 1696 and which, though partly dispersed, have come down to us, can see him like that. Newton was not the first of the age of reason. He was the last of the magicians, the last of the Babylonians and Sumerians, the last great mind which looked out on the visible and intellectual world with the same eyes as those who began to build our intellectual inheritance rather less than 10,000 years ago. Isaac Newton, a posthumous child born with no father on Christmas Day, 1642, was the last wonder-child to whom the Magi could do sincere and appropriate homage.

Keynes was thinking of Newton’s personality, and of his interests in alchemy and religion as well as in mathematics and physics. But in Newton’s mathematics we also

find the first significant step toward a worldview that transcends and unites both rigid law and flexible flux. The universe may appear to be a storm-tossed ocean of change, but Newton – and before him Galileo and Kepler, the giants upon whose shoulders he stood – realized that change obeys rules. Not only can law [*nomos*, *analogia*] and flux [*anomalía*] coexist, but law *generates* flux. Today's emerging sciences of chaos and complexity supply the missing converse: flux generates law.

...¹³

As Ian Stewart maintains, theoreticians during the 1990s have espoused a science known as Complexity,¹⁴ in an endeavour to penetrate the mysterious underpinnings of material reality. Complexity investigates adaptive dynamical systems and organisms; it is a broad discipline which subsumes even the much-touted Chaos Theory. One postulate of Complexity is that the morphologies of labyrinthine physical phenomena are often best apprehended by analysing them hierarchically, as interdependent, mutually influential behaviours or formations which act across many structural planes, all being governed or generated by relatively simple but abstract equations – one might even regard these equations as basic ‘laws’ or ‘principles’ – that underlie the whole edifice.¹⁵ Such a perspective upon nature reveals its power through conciliating and unifying ostensibly heterogeneous forms. So, by approaching composition in the same way (that, for me, writing music involves the creation of multidimensional, holistic, life-like sonic objects whose formal and acoustic richness I aspire to match with constructs found throughout the Cosmos itself), I aim to compose a ‘Natural music’ – in the Boethian category *musica mundana* – which could even be a true *musica humana*, a mystical, spiritual music that upholds (as I have written elsewhere) “diversity embraced in *unity* – *rapprochement* and interreferentiality in deep conceptual abstraction, beyond superficial, fictitious dualisms”.¹⁶

In this aspiration, I must confess something of a theological impetus: as a Christian intellectual, I wish not only to extol the transcendent Creator (and the Creation) through my music, but also to propound the lovely panentheistic doctrine of *unity* – that physicality itself continues to be sustained by this Deity who is also immanent, and so all things which exist may eventually be resolved within the Godhead, the One,¹⁷ that Monad of Absolute Reality.¹⁸ Increasingly, I try to traverse the ‘gaps’ between my music’s variegated elements by binding them together, proportionately and algebraically, into a vibrant Pleromatic fullness – for although unity does delight in differences, unless they are made to coexist harmoniously within some transcendent unifying sphere, then I will have failed as a composer, because “[unreconciled] multiplicity is a mark of inferiority in a Platonic structure”.¹⁹ Indeed, together with the visionary genius Karlheinz Stockhausen, I intuit that

... A new religiosity has to be established. I believe that, for example, the pure, abstract arts acquire a new purpose in this development – to connect man with the mysterious vibration structures of the entire cosmos. Therefore it can be said that if

one sees, grasps, and understands the deeper meaning of a musical work of art, [then] one will eventually become a humble admirer of God. One will become aware of the intelligence of the universe that pulsates through everything. And one will also realize that the composer is a servant, an assistant to the universal God who creates such a wonderful work of art.²⁰

But how does one even begin to regard the Divine? There are, historically, two theological approaches toward God – these being usually thought of as polar opposites. The theory of Emanations “declares [God’s] utter transcendence”,²¹ whereas for those who are adherents to the doctrine of Immanence, “the quest of the Absolute is no long journey, but a realization of something which is implicit in the self and in the universe: an opening of the eyes of the soul upon the Reality in which it is bathed. For them earth is literally ‘crammed with heaven’”.²² Yet certain mystics seem to view the Godhead from both perspectives at once, mediating them through a superlunary panentheism:

It is worth noticing that both [of] the theological doctrines of reality [i.e. the theories of Immanence and of Emanations] which have been acceptable to the mystics implicitly declare, as science does, that the universe is not static but dynamic; a World of Becoming.²³ According to the doctrine of Immanence this universe is free, self-creative. The divine action floods it: no part is more removed from the Godhead than any other part. “God”, says [Meister] Eckhart, “is nearer to me than I am to myself; He is just as near to wood and stone, but they do not know it”. These two apparently contradictory explanations of the Invisible have both been held, and that in their extreme form, by the mystics: who have found in both adequate, and indeed necessary, diagrams by which to suggest something of their rich experience of Reality. Some of the least lettered and most inspired amongst them – for instance, St. Catherine of Siena, Julian of Norwich – and some of the most learned, [such] as Dionysius the Areopagite and Meister Eckhart, have actually used in their rhapsodies language appropriate to both the theories of Emanation and of Immanence. It would seem, then, that both these theories convey a certain truth; and that it is the business of a sound mystical philosophy to reconcile them. ... A good map then, a good mystical philosophy, will leave room for both [of] these ways of interpreting our experience. It will mark the routes by which many different temperaments claim to have found their way to the same end. It will acknowledge both the aspects under which the *patria splendida* Truth has appeared to its lovers: the aspects which have called forth the theories of emanation and immanence and are enshrined in the Greek and Latin names of God. *Deus*, whose root means day, shining, the Transcendent Light; and *Theos*, whose true meaning is supreme desire or prayer – the Inward Love – do not contradict, but complete each other. They form, when taken together, an almost perfect definition of that Godhead which is the object of the mystic’s desire: the Divine Love which, immanent in the soul, spurs on that soul to union with the transcendent and Absolute Light – at once the source, the goal, the life of created things.²⁴

All of these theologies correlate precisely with my own ideal ‘compositional doctrine’ (which I do try to render more fully within each successive piece): a unifying principle irradiates a work, immanently, throughout all of its formal strata and content; however, such a unifier is also transcendent in that it reaches out beyond the work itself to connect meaningfully with both nature and culture – semiotically, mimetically ... and sometimes

even structurally (wherein a composition's underlying geometric pattern remains partly 'virtual', finding its culmination only conceptually, by implication).²⁵ For me, the Creation (which also embraces the microcosmic inventiveness that is genuine human creativity) perforce harmonizes oppositions, in homage to our Creator – such veneration of the All-Holy being (I believe) the true, ultimate purpose of Art:

... Creation is the subject of the scientist's search and mystical commitment, and it is the source of all worship and the goal of all morality. The mystic seeks a New Creation – where the wolf and the lamb in us lie down together, where strength and gentleness are faced and welcomed in hospitality, where animus and anima, male and female, as well as all paradoxes are reconciled in a living, whirling, laugh-filled dance to the erotic Godhead who painted us all, sang us all, gifted us all, imagined us all, and still laughs at us all. ...²⁶

Indeed, my composerly outlook and *raison d'être* could, with some validity, even be dubbed Zionist,²⁷ for the real definition and utmost meaning of Zionism – delineated symbolically by the sacred "New Jerusalem" mandala (an entelechy which happens to undergird my alto flute solo, **Dimensiones Paradisi**) – encompasses the harmonization of contrary forces:

... for the primary function of the Heavenly Jerusalem and the studies associated with it is to identify opposites and to include them together in harmony within a conceptual framework which allows their differences to be transcended. In the same way as the New Jerusalem diagram provides the matrix which unites disparate systems of geometry, the concept of Heavenly Jerusalem is sufficiently wide to embrace all sides in any mundane dispute, set them together within an orderly pattern and thus demonstrate their essential unity. This method of reconciliation is based on transcendence, meaning that problems are raised to the point where the interests of all sides become identical. ...²⁸

In order to embody such a paradigm of overarching unity, my music is, necessarily, complex.²⁹ But beyond its emulation of the Cosmos, I do believe that the labyrinthine, esoteric nature of my composition also epitomizes my own personal theology – and hints at the real character of God. Our Divine Creator, I conclude, is exceedingly complex (far beyond all human understanding and imagination),³⁰ and so is infinitely mysterious; thus, by analogy, any religious credo or music which purports to revere properly the Godhead, should flaunt an appropriately high degree of unity, intelligence, mystery, richness, and paradox.³¹ Like those of the fifth-century mystic Denys the Areopagite and the fourth-century Cappadocian Father Gregory of Nyssa, mine is an apophatic theology, a *via negativa* – one of deep silence centred upon the unknowability of God, who is above all language and all human thought.³² How, indeed, could it be any other way? After all, in our Cosmos there seems to be a teleological vector, acting macroscopically, towards simplicity from complexity, from an elaborate 'order' to the uniformity of 'disorder' (imagining the ultimate entropic state of our Universe ... absolutely cold, monolithic, dark and dead) – so

that by extrapolating backwards to the Creator, one might reasonably surmise that God, the Primal Cause, is the *ne plus ultra* in complexity: so much so that, to our conspicuously finite minds, we are very often deceived into accepting that the Supreme Being is simple.

Perhaps such benightedness – incorporating a profound and widespread alienation from nature – explains the current plethora of simplistic beat-driven music, which is typically reliant to a sizeable extent upon *literal repetitiousness*. Nowadays, excessive periodicity in music is something that I regard as both potentially deleterious to the human condition (because it tends to promote corporeal stimulation at the expense of mental engagement), and unnatural. Our Cosmos undeniably shuns exact repetition; rather, the Creation itself parades a bewildering variety, variegation and complexity across many architectonic planes of existence.³³ Anyhow, the following dialogue between the American composer Stuart Saunders Smith and percussionist Tom Goldstein encapsulates my own feelings about overly repetitive music enslaved by the regularity of ‘the beat’:

[STUART SAUNDERS SMITH] ... Periodic music puts sound on an assembly line. ... I am keenly aware of many coexisting time currents we experience in our daily life. Interestingly, with the exception of certain machines, none of our experiences are temporally periodic. Sunrise, heart-beats, breathing, blinking eyes, the entire natural world runs on aperiodic time. Therefore, I contend that music based on aperiodicity is more corporeal and rooted in our existence more than “dance” music or march music.
...

[TOM GOLDSTEIN] *I understand your reactions to march music, but aren't you making quite a leap in connecting all periodic music to march music? How would you reconcile your love of much periodic music (e.g., European classical, Indian, jazz) with your seeming disdain for periodicity?*

[STUART SAUNDERS SMITH] March music is at the extreme end of a periodic-music continuum. March music is absolutely symmetrical. Its purpose is military or paramilitary. Other music like jazz, rock, various ethnic musics use periodicity each in quite different ways. What they have in common is the surface supremacy of the foot over the head. That is, it is easy to let the body react to the beat without engaging the mind. I find this a dangerous situation. There is a disconnection between our moral center and visceral selves. Therefore, I am not in favor of periodicity any longer in any form. This does not mean I am no longer entertained or moved by periodic music, it means I disapprove of it. ...³⁴

What, then, makes a musical ‘composition’? The etymology of this word is quite illuminating: it derives from the Latin *compositio[nis]* – “[of] a putting together”;³⁵ that is, an orderly arrangement which constitutes a structure. Hence it could be argued that composition is concerned with formal relationships prior to, or simultaneously with, the consideration of sound (or its absence). Ideally, I myself prefer to conceive together every one of a composition’s structural tiers, from its macroform down to its microscopic sound-minutiae, so as to create a unified, holistic entity. For me – as with all of those artists who have subscribed to the perennial cosmology – the perfection of a compositional structure

is of paramount importance in expressing eternal truths and meanings:

Art – no less than philosophy or science or religion, or any other of the higher endeavors of the human mind – aims ultimately at knowledge, at truth. ... [Martin] Heidegger has tried to find the right term for it: he calls it “working-itself-out of truth”. Man in his artistic creation aims at truth. His imaging is a way of knowing; the intellectual process that leads to an image or a form is a way of thinking. In tones and tonal forces man discovers an original and infinitely fruitful material for his creation of images and his thinking in images. The same material can be used for entirely different purposes too. But to the creative artist, it opens one path to truth. Thinking in tones, forming in tones, he tries to let truth work itself out.³⁶

The Parisian master architect, Jean Mignot, overseeing the building of the cathedral in Milan in 1398, declared *Ars sine scientia nihil* [Art without ‘science’ is nothing]. This was in answer to an opinion then beginning to take shape, that *scientia est unum, et ars aliud* [‘science’ is one thing, and art is another]. For Mignot, the rhetoric of building involved a truth to be expressed in the work itself, while others had begun to think ... of houses, and even of God’s house, only in terms of construction and effect. Mignot’s *scientia* cannot have meant simply engineering, for in those days engineering was considered an art, not a science; his *scientia* meant *ratio* [or *logos*], the theme, content, or burden (*gravitas*) of the work to be done, and was not concerned with its functioning or with the esthetic satisfaction it might provide. And so, too, for music. ...³⁷

Looked at in such a way, one can still discern a remarkable kinship between music and mathematics, since both disciplines explore abstract structures and relationships. But whereas mathematics pervades a noetic (topo)logical-algebraic landscape, the act of composing (for me) occupies a kind of musical ‘truth-space’ – one which is much more convoluted, and (in a logical sense) more ‘fuzzily undecidable’,³⁸ than any formal axiomatic system in mathematics.

And, just like mathematics, music too has evolved its own monumental notational language, to enable composers to encode and preserve in a more permanent form whatever truths their compositions might have to offer. But is a piece of music’s notation merely a set of explicit instructions to those who are to articulate a work’s ‘truth-space’ in concert – its performers? No: I insist that notation also serves to elucidate a composition’s structure,³⁹ whereby a score may self-reflexively ‘analyse itself’.⁴⁰

Much of my own music inhabits a world dominated by interpretative rubato, returning the responsibility for the expressiveness of the music to the individual player ... the notation ... requires the performer to accept that, as they cannot play what is before them literally, *it must mean something else* (unless they think I’m a fool ...), and in finding that other thing, the performer is liberated and empowered by the understanding that what the notation *really* means is that I trust them sufficiently profoundly not to treat them as bowing, blowing or thumping robots. That I entrust them with *understanding and revealing* my personal composerly vision.⁴¹

Perhaps my desire (most of the time) for maximum notational precision is indicative of a Neoplatonic *Weltanschauung* – which evinces an overwhelming drive to portray some

archetypal 'ideal plan' in an art-work.⁴² However, within my *œuvre* I do sense what feels like a wide divergence – a yawning chasm – between degrees of notational specificity.⁴³ at times, this seems uncomfortably like a 'split compositional personality', the reasons for which I cannot fully communicate. (And yet, thankfully, I am able to detect in my work a consistency of meaning and purpose that overrides the issue of notational detail.) In any event, notation is cerebrally liberating because it is mnemonic: the mind is thereby freed to imagine thence contemplate deeper creations. While sketching and notating a piece, one is now capable of holistically envisaging complex forms across numerous architectonic time-spectra – from frequency/timbre through to its macrostructural scaffolding – so as to circumvent the monodimensionality of a 'sonically rich veneer' devoid of relational substance (such as one frequently encounters in illiterate popular musics). Naturally, such intricate yet notatable musical networks are rarely through-composed 'in time', but instead may be honed in abstract, 'outside time': the entire edifice might then be grasped in an instant – not just locally, moment-by-moment (or phrase-by-phrase). One is therefore able to interrelate various compositional parameters and structures in ways that are simply unthinkable without musical notation.

But if notation encourages internal relationality within a composition, what, then, of composers themselves working within society at large? Certainly, some Western composers appear to be (or to have been) shamans capable of bridging the Worlds of Being and of Becoming; such oracular vessels of 'acoustical truth' are alchemistic translators of concealed spiritual realities into sound and silence...

'I am electrical by nature. Music is the electric soil in which the spirit lives, thinks, and invents'. ... this is Beethoven speaking to Bettina Brentano. Composers from Bach and Beethoven to Schönberg, Stravinsky, and especially Webern thought of themselves as vessels of spiritual transformation ... of musical alchemy ... Most contemporary Western composers seem to look askance at any thaumaturgical attribution or explanation of their musical inspiration and efforts. And yet it was Webern himself who ultimately identified scientific processes and inspired creation: '[It's for a later period to discover the closer unifying laws that are already present in the works themselves. When this true conception of art is achieved, then there will no longer be any possible distinction between science and inspired creation.] The further one presses forward, the greater becomes the identity of everything, and finally we have the impression of being faced by a work not of man but of Nature'. And Webern also wrote: 'I understand the word "Art" as meaning the faculty of presenting a thought in the clearest, simplest form, that is, the most "graspable" form. Given this, I cannot conceive of Our Father as being something antithetical to art; rather it is the highest example. For it achieves the greatest "graspability", clarity, and directness'.⁴⁴

I extol, and persist in celebrating the perilous existence of, High Art (defiantly, in the face of a hostile postmodernism with its doctrine of ochlocracy); I still do believe in the nurturing of a musical canon, of an élite compositional body that soars above a vast morass of mediocrity. I defend to the death the outpourings of that 'invisible academy' of

composers (almost never spotlighted by mass media) who continue to uphold artistic and craftsmanly excellence, who keep on averring composerly intelligence, and who evince musical individuality while exhibiting true originality, sophistication, and an aristocracy of sentiments: such composers resonate meaningful *difference* through strong creative voices that provide a profound counterpoint to those belonging to any popular mainstream; by continually expanding our sonic universe, such composers beget its dynamism, its very life – and bestow upon the world an ever-growing corpus of music towards which any soundsmith might aspire. In this light, I am proud to assert that I am a cultural élitist – one who utterly rejects the torpor of ‘passive reception’ demonstrated by many audients (who, in their ignorant arrogance, demand immediate gratification via instant, comprehensive comprehensibility ... however ‘difficult’ be the music) while nevertheless desiring exposure of my own compositions to anyone who is just willing to *listen carefully*.⁴⁵ But perhaps there is also an aberrant psychological impetus at large here, I concede. (How indeed could it be otherwise?) All my life, like it or not, I have been an outsider, an outcast even – rejected by Australia’s social *Zeitgeist* because of my unabashed ‘otherness’, my intensity, and my uncompromising love of arcana. In response, I embrace this lonely exile, critiquing ‘from without’ thence renouncing much that our contemporary society and the global economy appear to hold dear.

As a composer – and as a reflective human being – I am, alas, out of step with the times, which value shallowness and frivolous divertisement: instead, I prize *profundity*.⁴⁶ I remain very disillusioned with a great deal of what passes for contemporary Western ‘culture’, much of which I adjudge as dystopian. Perhaps it would have been more apt had I titled this thesis “A World of *Unbecoming*”, given that the positive artistic values I espouse herein (and will forever exalt) are increasingly disconnected and far-removed from what nowadays, I regret, an ever-bloating body of music reveals ... and even revels in: crassness, clichéd pastiche, superficiality, things quotidian, unintelligence,⁴⁷ a lack of ‘soul’, technical incompetence, unimaginativeness, and (dare I say it) *outright stupidity*. Understandably, one might lapse into a state of barren despair; however, I shall try – somehow – to stay optimistic. I envision a counterpoise to this postmodern predicament, to which I add weight by creating works of art that eschew such negatives. Through this ‘creatorly difference’, I reap purpose and meaning; through compositional distinctiveness, I sense the making of a genuine contribution to the cultural wealth of the community.

Hence I cultivate my art, in private, contrary to Western society’s prevailing predilection for musics that merely amuse (whereby artistic worthiness is blithely conferred in direct proportion to profit margins, quantifiable popularism and ‘accessibility’ through crudeness), and thus – by proffering alternatives – serve the public authentically through proposing

some other ways to be and to listen. So permit me to enunciate some personal yardsticks: unless one's music discloses *individuality* (some facet that is truly unique to oneself), then I can see no reason for it to exist; also, I despise banality and blandness. I affirm that rich sound-content integrated into a labyrinthine structure is, decidedly, a virtue: the near-instantaneous assimilability of so much recent (art-)music is not for me, ever.⁴⁸ Rather, I want listeners of my music to enjoy a 'perpetual freshness' – that they may apprehend during each and every hearing of one of my pieces (even for the hundredth time!) details therein which were previously unappreciated by them. Composing, at least for me, is therefore an act of love towards the society in which I live; it is a mysterious crucible wherein

... the act of creation takes on meanings which will inevitably colour the product: the composer becomes a cartographer, exploring previously unrealized states of musical being, and a shaman, manifesting these states wholly or partly transformed so as to be assimilable by his/her audience. The attempt to share this vision is an investment of generosity [of] spirit which is certain to irradiate the resulting artwork; ...⁴⁹

But beyond the sociology of composition, which is concerned with composers' (musical) rôles amidst their local communities, I ask: where do we fit into the world on a planetary scale? Although it has been fashionable over the years for many Australian composers to consider and discuss their 'Australianness', on a parallel with the eminent Australian art theorist Bernard Smith (and also being somewhat influenced by my friend, the composer Colin Bright), I am nowadays rather more interested in composing a non-nationalistic 'Pacific music', because

[i]t seems to me that for some of our composers, the defining factor of Australian culture is merely stylistic/geographical: a rejection of things European (while becoming an American clone). But for others [such as Colin Bright, Bruce Cale, and Anne Boyd] ... perhaps a 'deeper cartography' is at work, wherein musics-of-this-place are being forged without a rejection of anything *per se* ... except, maybe, 'X-centricity'.⁵⁰

For although I continue to keep myself musically well-informed and remain respectful of high culture (whatever or wherever its origins), I simply do not feel the oppressive weight of European – or indeed any other – musical traditions. My compositional sensitivity to timbral and micro-intervallic nuances, as well as my fascination with formal non-teleology, could well have emerged from my exposure during the early 1980s to Japanese *shakuhachi* music or, equally, from being immersed around the same time in the musics of Olivier Messiaen, Igor Stravinsky, Edgard Varèse, Iannis Xenakis, Carl Ruggles, and Harry Partch: my composerly roots seem to lie nowhere in particular.

And the same observations might well be made about my preferred musical media: I write mostly for unusual, non-standard, or even unique chamber-music combinations. Why

is this so? “The medium is the message” – in part... Now aside from the quite invaluable opportunities that such instrumentations pose for investigating relatively fresh, unexplored sound-worlds, and beyond mere pragmatism (composing for one’s colleagues; responding to their commissions), I do find that most traditional Western forces – like the string quartet – often carry an unbearable burden of repertorial precedence over which I would always feel the ineluctable obligation to prevail; their very sounds usually convey far too much ‘historical baggage’ for me.⁵¹ Specifically – although I do greatly admire its galaxy of timbral constellations – works for orchestra are completely absent from **A World of Becoming**: despite never being commissioned by them, not one of the present-day Australian orchestras would be able to competently perform my music; they have become emasculated due to their shameful retreat from the ‘difficult’ modern(ist) repertoire. With only a handful of honourable exceptions, our symphony orchestras nowadays play ‘contemporary’ pieces that are chiefly epigones of retrospectivity. Though once a vivacious compositional context, the orchestra in Australia has quite recently passed away into being a moribund ‘historical medium’ which plays almost nothing with a cutting edge; it is now just like the krummhorn consort, in that its repertory has ceased to expand with genuinely new music. I also judge the politics of the orchestra – both internal and external (saturated by, and servile to, bourgeois society, with its profiteering mentality) – to be increasingly intolerable.⁵²

Likewise, I will probably never entertain the thought of naming any of my compositions “Symphony”, “Sonata”, “Concerto”, “Suite” ... or whatever other hackneyed conventional title comes to mind: these, too, entail an inordinate number of historic antecedents. Rather, my penchant in musical names is for novel, enigmatic epithets that exude polysemy – transmitting several dendrites of meaning, all of them intentional. For the sake of compositional unity, I also espouse the ideal expressed by this delectable morsel from the ancient poem **Thunder, Perfect Mind** – “I am the voice whose sound is manifold and the word whose appearance is multiple. I am the utterance of my name.”⁵³ – in that pieces of mine such as **Dimensiones Paradisi**, **[p]s(t)ellor/mnême**, **Arc of Light**, **Cosmos (One Note)** and **Lines of Light: Seven Improvisations on αιθερος μελος** are truly (inasmuch as it is possible) multihued, integrated ‘utterances of their names’.⁵⁴

My music is also one of secrecy ... of codes, cyphers and encryptions: just like subatomic particles, its force-fields remain hidden⁵⁵ – though their effects may be perceived readily enough. Indeed, I am diametrically opposed to any music that betrays its anatomy, rendering its processes overt:⁵⁶ such a vulgar compositional gimmick rapidly induces boredom and annoyance in this listener. Moreover, I do not wish to embolden

potential imitators of my music, particularly those who in the end are unable to seriously care about – let alone understand – what my compositional procedures and techniques symbolize (and among whom isolated ‘number crunching’ would thus be utterly sterile and profane);⁵⁷ I choose to talk about such recondite matters only with those trusted friends who appreciate the sacred significance of my compositional schemata. Just as one would honour and defer to the entreaties of a tribal elder, composers must be sanctioned to protect their creative secrets and private methodologies.

For a real alchemist – and the best composers are truly ‘magicians of time’ – never publicly bares all of his arcana...

1.2 RECURRENT COMPOSITIONAL TECHNIQUES

In the process of unveiling the various compositional techniques and epicompositional stimuli with which I have been preoccupied over recent years, the twelve subsections below will canvass – wherever appropriate – each technique’s theoretical or mathematical underpinnings (in conjunction with a specific example), together with my own composerly impetuses – artisanal, aesthetic, and semasiological – for adopting the technique into my music, as well as any relevant historical perspectives of which I am aware. When a technique does give rise to numerous compositional paths along which one might proceed, I will try to recollect those criteria that were important to me, and so articulate a rationale for choosing a particular option. And, at the very least, I shall also furnish a single instance of each technique’s deployment within one of my pieces herein.

Yet it also needs to be registered that this section is not at all intended to be exhaustive: rather, I propose to focus only upon those musical devices which to me seem meaningful insofar as I have repeatedly exploited them – whereby they are now very much a part of my own compositional idiolect. (Moreover, the somewhat limited textual scope of **A World of Becoming** definitely precludes the possibility of me shedding light on every latent nuance concealed within each of these techniques.)

The ordering of the twelve subsections 1.2.1 to 1.2.12 that I finally settled on is to some extent chronological – those techniques examined in earlier subsections do tend to manifest themselves first in earlier compositions. But there is also a vague hierarchy of precedence here: the earlier subsections deal with quite basic compositional ideas, fundamental building-blocks that often intertwine with those methods discussed later. Hence, one might hopefully be able to glimpse a vector of expanding technical sophistication and complexity of musical thought as section 1.2 evolves.

Besides its pragmatic dimension, as a compendious ‘technical lexicon’ or gloss to which readers can refer (if need be) while they are poring over my analytical notes within later chapters, section 1.2 also serves as a continuation of – indeed, an amplification and a justification of – those aesthetic foundations that were laid down in the previous section. As such, section 1.2 does go quite a long way towards vindicating the statements made within my Abstract and buttressing the radical thesis of **A World of Becoming** – UNITY.

1.2.1 SYSTEMATIC PERMUTATION

A *permutation*, insofar as it is applied within a composition, consists of a specific rearrangement of an ordered set of ‘musical objects’ – such as durations, pitches, gamuts, timbres, textural densities, average numbers of attacks, dynamic levels or ranges, articulations, tempi, or even (non)algorithmic procedures. Given an ordered set Σ comprising n objects, we firstly number them 1 to n , so that Σ can be represented thus:

$$\Sigma = [1, 2, 3, \dots, n-2, n-1, n].$$

Let Π be some permutation of Σ . Then Π might be seen as an ‘isomorphism’, a one-to-one mapping of each element of Σ to an element of Σ such that Π includes all n elements: 1 becomes $\Pi(1)$; 2 becomes $\Pi(2)$; ... ; k becomes $\Pi(k)$; ... ; n becomes $\Pi(n)$. Therefore, $\Pi = \Pi(\Sigma) = [\Pi(1), \Pi(2), \Pi(3), \dots, \Pi(n-2), \Pi(n-1), \Pi(n)]$.

This same act of permutation, Π , can be iterated upon itself over and over again, a finite number of times, until the original set Σ is attained once more:

$$\Pi^2 = \Pi^2(\Sigma) = \Pi(\Pi(\Sigma));$$

$$\Pi^3 = \Pi^3(\Sigma) = \Pi(\Pi^2(\Sigma)) = \Pi^2(\Pi(\Sigma)) = \Pi(\Pi(\Pi(\Sigma)));$$

... ;

$$\Pi^k = \Pi^k(\Sigma) \equiv \Sigma.$$

Indeed, this reiterative permutational process generates a set – actually, a self-contained *cyclic group*, $\langle \Pi \rangle$ – of k distinct permutations, which may be simply notated $[\Sigma, \Pi, \Pi^2, \Pi^3, \dots, \Pi^{k-1}] = \langle \Pi \rangle$. Note here that $\Sigma = \Pi^0 \equiv \Pi^k$. The exact value of k is dictated both by n (the number of objects in Σ), and by the particular re-ordering that defines Π .

By way of illustration, consider $S = [1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13]$, and then rearrange the members of S in order to obtain $\Omega = \Omega(S) = [11, 13, 10, 2, 5, 9, 4, 6, 7, 12, 1, 3, 8]$. Each number (being representative of a ‘musical object’) in S is now thought of as correlating to the appropriate position within Ω , so that – for instance – 6 refers to Ω ’s sixth number (9), 3 to Ω ’s third number (10), and so on: $\Omega(6) = 9$; $\Omega(3) = 10$; etc. In other words, S ’s ninth number (9) becomes Ω ’s sixth number; hence the ninth number of Ω – 7 – will be the sixth number of Ω^2 , etc. Thereby, Ω^2 can be deduced in full – $\Omega^2 = [1, 8, 12, 13, 5, 7, 2, 9, 4, 3, 11, 10, 6]$ – and so one is now able to tabulate progressively the entire cyclic group $\langle \Omega \rangle$ of k distinct permutations produced by Ω acting repeatedly upon itself:

$$S = [1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13] = \Omega^0;$$

$$\Omega = [11, 13, 10, 2, 5, 9, 4, 6, 7, 12, 1, 3, 8];$$

$$\Omega^2 = [1, 8, 12, 13, 5, 7, 2, 9, 4, 3, 11, 10, 6];$$

... ;

$$\Omega^{41} = [11, 4, 12, 7, 5, 8, 9, 13, 6, 3, 1, 10, 2] = \Omega^{-1};$$

$\Omega^{42} \equiv S = \Omega^0$. (It turns out that for the permutation Ω , $k = 42$; the reason why this value for k occurs shall be elucidated below.)

It is, however, often tedious or even downright impractical to write out completely such an array of $n \times k$ numbers. Fortunately, there exists a rather more elegant and compact method of characterizing Ω and its cyclic group $\langle \Omega \rangle$ which, aside from its extraordinary succinctness, also possesses the advantage of readily revealing certain internal structures – autopoietic ‘subpermutations’: autonomously self-productive *cycles* – that would otherwise not immediately be apprehended from the fully notated table.

Observe what happens to the members 1 and 11 of S when Ω operates upon S : we see that $\Omega(1) = 11$ and $\Omega(11) = 1$; so $11 = \Omega(1) = \Omega(\Omega(11)) = \Omega^2(11)$, and similarly $1 = \Omega(11) = \Omega(\Omega(1)) = \Omega^2(1)$. Put less abstractly, upon each successive application of Ω to itself, the numbers 1 and 11 alternate places, swapping between the first and eleventh positions of consecutive permutations. Likewise, $\Omega(5) = 5$, and so $\Omega^m(5) = 5$ for any integer m : 5 remains in fixed order as the fifth element of every permutation belonging to $\langle \Omega \rangle$. Furthermore, $\Omega(3) = 10$, $\Omega(10) = 12$ and $\Omega(12) = 3$, so that: $3 = \Omega(12) = \Omega(\Omega(10)) = \Omega^2(10) = \Omega^2(\Omega(3)) = \Omega^3(3)$; correspondingly, $10 = \Omega^3(10) = \Omega^2(12)$, and $12 = \Omega^3(12) = \Omega^2(3)$. Throughout $\langle \Omega \rangle$, then, this closed three-member subset of S is rotated cyclically – $[3, 10, 12]$, $[10, 12, 3]$, and $[12, 3, 10]$.

These six members of S – 5; 1 and 11; 3, 10 and 12 – therefore comprise the three smallest cycles of Ω , all of which are capable of propagating various ‘subpermutations’. We notate them as follows: (5); (1, 11); and (3, 10, 12). The members in these cycles permute cyclically amongst themselves, so that at each step in subsequent implementations of Ω to itself, 3 becomes 10 becomes 12 becomes 3, etc. As it happens, the largest (and indeed the only unaccounted-for) cycle of Ω embraces seven elements – (2, 13, 8, 6, 9, 7, 4) – so that now we can render Ω as:

$$\Omega = (5) (1, 11) (3, 10, 12) (2, 13, 8, 6, 9, 7, 4).$$

In fact, all forty-two permutations of $\langle \Omega \rangle$ itself are concisely designated by just these

four cycles.

The quantity of members found within a given cycle is known as its *length*. If a permutation Π (as defined previously) is composed of c disjoint cycles of length n_1, n_2, \dots, n_c (i.e. $n = n_1 + n_2 + \dots + n_c$), then k – the number of discrete permutations in the cyclic group $\langle \Pi \rangle$ – will be equal to the lowest common multiple of the lengths of Π 's cycles: $k = \text{l.c.m.}\{n_1, n_2, \dots, n_c\}$. Hence, for Ω , we conclude that $k = \text{l.c.m.}\{1, 2, 3, 7\} = 42$.

While discussing groups of permutations above, moreover, a notational protocol for analysing the systematic rearrangement of objects has gradually emerged. Let us now establish this symbology explicitly. Numbers enclosed within curly braces – $\{ \}$ – represent unordered sets of objects, whereas numbers between orthogonal brackets – $[]$ – denote a specific permutation of such objects, in which their ordering is crucial. Numbers listed within parentheses – $()$ – define the cycles of these (sub)permutations.¹

Probably the most celebrated composely exponent of systematic permutation was Olivier Messiaen, whose “interventions”, in works such as **Couleurs de la Cité Céleste** (1963), are rhythms built wholly from integer multiples of a *chronos protos* that are then re-ordered methodically to form a cyclic group.² Throughout Messiaen's *œuvre*, this cyclic permutational device is applied solely to rhythms, however, in a manner which is utterly independent of the rhythmic material being permuted. With some of my own compositions in **A World of Becoming**, though, one will encounter such permutation groups being concurrently brought to bear upon durations from two or more architectonic tiers, as within **Lines of Light: Seven Improvisations on αιθερος μελος**: the same permutation group therein re-orders both the piece's sections and its subsectional spans. **Lines of Light** also engages a second permutation group to rearrange reservoirs of pitches – ‘harmonic fields’ – within this piece; so, other musical objects besides rhythmic elements are systematically permuted in my music, and a work of mine might employ more than one cyclic group to function autonomously upon different aspects of the composition.³

Whenever constructing a permutation, unlike Messiaen it seems, I always necessarily bear in mind certain key factors that stem from the algebraic properties of permutation groups as well as from particular attributes of the musical objects to be re-ordered: a permutation's cyclic structure and the material upon which it will operate are to some degree interdependent in my music. What are these compositional factors? If for one moment we consider the eristic issue of perception (whether or not a listener is able to recognize any permutational relationship between collections of musical objects, should this be deemed relevant),⁴ then several criteria need to be taken into account:

1. For an ordered set Σ of n objects that are to be permuted by Π , the larger that n becomes, then cognitively, it will be increasingly less likely that one shall be able to appreciate the fact that a permutation of Σ (as opposed to some other type of transfigurement) has occurred. Systematic permutation is more easily discerned when small numbers of musical objects are involved.
2. Once n has been decided upon, it will be seen that the number n itself can be *partitioned* – broken down into a set of smaller integers that sum to n – in numerous ways. In envisioning Π as a collection of disjoint cycles, we now understand that decomposing n does convey ramifications for k (the cardinality of the cyclic group $\langle \Pi \rangle$) because k equals the lowest common multiple of the cycles' lengths. So, by manipulating the manner in which n is partitioned, as a prelude to determining the total number of cycles in Π and their lengths, we can anticipate the magnitude of k . It has been my experience that, on the whole, a trade-off entails: whenever k is relatively large, the variations in number-order between certain permutations that are members of $\langle \Pi \rangle$ may seem negligible – in which case such permutations are heard to be much the same; conversely, for smaller values of k , the permutations belonging to $\langle \Pi \rangle$ will probably sound quite distinct from one another.

For instance, with $n = 13$, the maximum value of k happens to be 60 – based upon the partition $13 = 1 + 3 + 4 + 5$, whence $60 = \text{l.c.m.}\{1, 3, 4, 5\}$. In our earlier permutation example $\Omega = (5) (1, 11) (3, 10, 12) (2, 13, 8, 6, 9, 7, 4)$, where $k = 42 = \text{l.c.m.}\{1, 2, 3, 7\}$ – this being the second-largest possible amount for k whenever one reiteratively permutes thirteen objects – it turns out that within $\langle \Omega \rangle$, for any integer m , every pair of permutations Ω^m and Ω^{m+21} are identical twins (almost), aside from the numbers 1 and 11 having interchanged places: eleven out of their thirteen objects occupy exactly the same positions.

3. When we do know what the algebraic structure of Π will be, the question of where specifically the numbers 1 to n shall be put within Π 's cycles then looms. This is a complicated topic, about which few general recommendations can be made. However, I do believe that it is prudent to cogitate calmly over the 'beginnings' and 'endings' of permutations: the locations of the numbers 1 and n in Π should be well contemplated, for the sake of 'perceivable differences' between the permutations; in order to guarantee variety, I often find it best to place 1 and n within cycles that are not too short. As for the numbers 2 to $n-1$, their deployment is usually contingent upon the nature of the musical objects to which they correspond. Decisions here are reached on the basis of miscellaneous circumstances: for aesthetic reasons, I insisted that one

permutation at play in **[p]s(t)ellor/mnême** would ensure that this work's penultimate section was the longest; the permutation group that rearranges durations within **Cycles of Vega** was formulated in such a way that certain 'irrational' rhythmic groupings are always kept together,⁵ sequestered from other durational types – i.e. the numbers correlating to matched 'tuplets' were mutually constrained within the same cycle.

4. Whenever there exist musical objects within Σ which are identical (coeval durations, for example), the individuality of some permutations in $\langle \Gamma \rangle$ – not to mention the cyclic group's algebra – will probably be muddled somewhat.

For certain pieces of mine that resort to the systematic permutation of durations, the process of narrowing the range of permutational possibilities and at last choosing a specific permutation has been greatly expedited by the manipulation of *physical commodities*. So, for the purpose of implanting a visual component into this process, cut-up pieces of cardboard (whose relative widths are proportional to their analogous durations) were numbered, lined up, then repeatedly transposed until I was satisfied that the 'seed permutation' to be at large in **[p]s(t)ellor/mnême** had finally been elicited.⁶

Systematic permutation undeniably exudes *unity*, since the permutations within a cyclic group all spring from just one generative permutational act. One is powerfully reminded of Messiaen's maxim "the charm of impossibilities", alluding to a cyclic group's autopoietic self-containedness – whereby a permutation's proliferative potential nevertheless cannot admit foreign elements from another cyclic group. And yet this compositional technique also manifests *diversity* within unity: typically, when the number of musical objects to be permuted is not small, the resulting cyclic groups circumscribe a veritable *embarras de choix* of permutations.⁷

As a fecund transformative procedure, systematic permutation is a natural metaphor for the periodic motions exhibited by cosmic bodies – such as the orbital cycles and rotations of planets. Herein lies this compositional technique's *meaning* (at least in part: it also brings forth metaphysical overtones). Indeed, in the mathematical jargon of the theory of permutation groups, the set of positions occupied by an object's number throughout all the permutations of a cyclic group is referred to as that number's *orbit*;⁸ these orbits equate with the permutations' cycles. So it is no fluke that my subtitle to **Zodiac** is "Crystal Orbit Improvisations", a poetic allusion to the frozen algebra of this work's permutation group, which systematically re-orders pitch-classes:⁹

My primal ordered set of eighteen chromatic pitch-classes (of which the first twelve by chance form a '12-tone row') in **Zodiac: Crystal Orbit Improvisations** is ∂^0 :

∂^0 pitch-classes: E \flat C \sharp C \flat F \flat D \flat G \sharp A \flat B \flat G \flat F \sharp D \sharp B \flat A \flat F \flat G \flat D \flat C \flat D \flat
ordinal numbers: 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18

Whence did this pitch-sequence originate? ∂^0 was composed so that certain pairs of pitches (as they are notated within the recorder part) approximated the constituent tones of some excellent soprano recorder multiphonics; otherwise, no further creative constraints really come to mind – except of course that ∂^0 and its permutations had to be somewhat engrossing melodically and intervallically. My procreative permutation ∂^1 , which shuffles the pitch-classes of ∂^0 , is:

∂^1 pitch-classes: D \flat C \flat C \flat B \flat B \flat D \flat D \flat F \flat D \sharp G \flat F \sharp G \sharp F \flat G \flat A \flat A \flat E \flat C \sharp
 ∂^0 ordinal numbers: 18 17 3 12 8 5 16 4 11 9 10 6 14 15 13 7 1 2

So $\partial = \partial^1 = (3) (7, 16) (9, 11, 10) (13, 14, 15) (1, 18, 2, 17) (4, 12, 6, 5, 8)$, and the cyclic group $\langle \partial \rangle$ therefore possesses sixty permutations ∂^0 to ∂^{59} , thirty of which have been distributed throughout this composition's three instrumental parts. However, I must avow that their permutational logic is perhaps confused by a second, supplementary re-ordering operation – *rotation* – which was then brought into play upon nineteen out of the thirty permutations: I opted to rotate nineteen permutations due to harmonic concerns in the keyboard synthesizer part as well as my desire, within the recorder part's twelve "modules", to overlap (wherever feasible) each module's initial "fractalous sonority" with the first of its permutable pitch-classes. What, then, is "rotation"? Let us commence with the permutation $\partial^7 = [17, 18, 3, 6, 4, 8, 16, 12, 11, 9, 10, 5, 14, 15, 13, 7, 2, 1]$; its first, eleventh and fifteenth numbers are 17, 10 and 13 respectively – and so on. Now rather than unfurling ∂^7 in its 'correct' order (as above), we *revolve* ∂^7 so that it starts instead from its seventh number (16), proceeds to its eighteenth and last number (1), then straight back around to its first number (17) and onward to its sixth number (8), for example: all eighteen objects have thereby been presented. Hence we write this particular rotation of ∂^7 as $\partial^7(\underline{7-6}) = [16, 12, 11, 9, 10, 5, 14, 15, 13, 7, 2, 1, 17, 18, 3, 6, 4, 8]$.¹⁰

Those permutations (and their sundry rotations) from $\langle \partial \rangle$ which I selected to be the 'threads' for the tonal fabric of **Zodiac: Crystal Orbit Improvisations** are:

AMPLIFIED SOPRANO RECORDER: ∂^0 ; ∂^1 ; ∂^2 ; ∂^{51} ; $\partial^{22}(\underline{2-1})$; $\partial^{34}(\underline{6-5})$; $\partial^{48}(\underline{7-6})$; $\partial^{11}(\underline{5-4})$;
 $\partial^{13}(\underline{9-8})$; $\partial^{27}(\underline{2-1})$; $\partial^8(\underline{7-6})$; $\partial^{33}(\underline{8-7})$;

MIDI WIND INSTRUMENT: ∂^{20} ; ∂^{46} ; ∂^{31} ; ∂^{37} ; ∂^3 ; ∂^{16} ;

KEYBOARD SYNTHESIZER: ∂^{40} ; $\partial^{25}(\underline{9-8})$; $\partial^{26}(\underline{7-6})$; $\partial^{43}(\underline{9-8})$; $\partial^{28}(\underline{9-8})$; $\partial^{21}(\underline{5-4})$;
 $\partial^{10}(\underline{9-8})$; $\partial^{39}(\underline{9-8})$; $\partial^{56}(\underline{7-6})$; $\partial^{49}(\underline{9-8})$; $\partial^6(\underline{8-7})$; $\partial^{15}(\underline{11-10})$.

Furthermore, we observe that (due to the algebraic structure of $\langle \partial \rangle$) the three

instruments' initial permutations – ∂^0 , ∂^{20} and ∂^{40} – possess identical orderings for twelve of their eighteen pitch-classes: notes 1 through to 8; 12; 16, 17, and 18.¹¹ In this light, then, **Zodiac: Crystal Orbit Improvisations** might be thought of as a 'broken canon' whose imitative voices soon gain autonomy – after their eighth pitch – or, rather, as a formulary 'comprovisation'¹² whose opening moments are temporarily heterophonic.

Returning once again to the semiotics of systematic permutation, maybe this serial technique's deepest (and most poetic) meaning of all is Kabbalistic: within the Jewish mystical tradition, some believe that systematic permutation mirrors the very act of Creation itself:

[LETTERS OF CREATION] Twenty-two elemental letters. God engraved them, carved them, weighed them, permuted them, and transposed them, forming with them everything formed and everything destined to be formed.

Twenty-two elemental letters. God set them in a wheel with 231 gates, turning forward and backward. How did God permute them? *Alef* with them all, all of them with alef; *bet* with them all, all of them with bet; and so with all the letters, turning round and round, within 231 gates. Thus all that is formed, all that is spoken emerges from one name.

Out of chaos God formed substance, making what is not into what is. He hewed enormous pillars out of ether that cannot be grasped.

When Abraham our father, peace unto him, gazed – looking, seeing, probing, understanding, engraving, carving, permuting, and forming – he succeeded in creation. Immediately God manifested to him, embracing him, kissing him on the head, calling him "Abraham, my beloved".¹³

As an archetype for microcosmic composerly creativeness and architectonic sculpturing via systematic permutation (amongst mortals, 'in *imago Dei*'), could one ask for more beautiful and noble imagery? And within this metaphysic, is not systematic permutation a truly sublime model of an arch that links God's transcendental 'World of Being' with humankind's in-time, hylic 'World of Becoming'?

1.2.2 LONG-RANGE REPETITIVE TIME-CYCLES

Introduction

As a compositional artifice, in and of itself a *long-range repetitive time-cycle* is really quite self-explanatory – but, should one spin out just a single time-cycle in technical isolation, this seems much too elementary (at least for my composerly palate). Rather, musical circumstances do become more intriguing once several expansive time-cycles of different lengths unfurl in counterpoint: they might then even be regarded as macroscopic homologues of some permutation group's algebraic cycles.

Repetitive time-cycles routinely give rise to *colotomic structure* – a “network of punctuation[s]”¹ or ‘hyperrhythm’ within a work – marked by the return of each cycle to its starting-point, or *colotomy*. So, given n repetitive time-cycles (all of which begin together) lasting respectively $d_1, d_2, \dots, d_{n-1}, d_n$ beats, when will their colotomies next coincide? Such a grand resynchronization shall occur after $b = \text{l.c.m.}\{d_1, d_2, \dots, d_{n-1}, d_n\}$ beats. (Thus, for example, setting $n = 3$ with $d_1 = 4$ beats, $d_2 = 5$ beats and $d_3 = 7$ beats, one may readily confirm that in this particular case, $b = \text{l.c.m.}\{4, 5, 7\} = 140$ beats.)

A time-cycle most obviously consists in an ordered set of durations; whenever its order remains fixed and the time-cycle repeats, the resulting temporal pattern is called an *isorhythm*.² However, a time-cycle can instead be characterized by a periodic sequence of pitches – if it stays invariant, we then gain an *isomelos* – or even by a recurrent progression of discrete timbres (thus making an *isochroma*) which have been superimposed upon some (iso)rhythm.

It is, in fact, a relatively simple matter to amalgamate these genera of time-cycles, wherein they may wheel away autonomously. One famous instance of such independent cyclical intermeshing from the twentieth-century canon arises within the serene introductory **Liturgie de cristal** movement from Olivier Messiaen's **Quatuor pour la Fin du Temps** (1941): the pianist plays therein an isorhythm accrued from seventeen durations, upon which has been laid an *isomelos* of twenty-nine chords; meanwhile, counterpointed against this pair of interlacing time-cycles, the violoncello weaves another polycyclical skein – a palindromic isorhythm comprising eighteen durations that itself incorporates an *isomelos* with five pitches (all of which belong to the same whole-tone scale).³

Epicycles

The Greek mathematician Apollonius of Perga (ca.262–ca.190 BC) is credited with introducing the concept of *epicycles* to help explain the erratic – and at times apparently retrograde – motion of the planets in our sky. (This geometrical device was subsequently prominent within the cosmological system developed by Ptolemy of Alexandria.) Epicycles were once used by astronomers

who explained the movement of the planets [through] a combination of circles. An epicycle was a small circle [whose centre lay upon the perimeter] of a bigger circle called the *deferent*. By adjusting the rate of movement of a planet around its epicycle, and the epicycle's rate of movement around the deferent, any required final motion could be reproduced. ...⁴

But within a piece of music, what might comprise an 'epicycle'? One possible answer is that an epicycle can be a revolving 'satellite' of some time-cycle: a subset of consecutive musical objects from a time-cycle may repeat itself cyclically *within* the time-cycle; alternatively, this subset's elements could be reiteratively permuted therein, perhaps even obtaining an autonomous existence outside the time-cycle, elsewhere within the composition.

Time and Culture

With the coming of Christianity (and, especially, the cosmic *uniqueness* of its crucial mystery: the historiophysical resurrection of Jesus), time within Western culture began to be perceived as a linear, even teleological phenomenon – as a temporality which is bottomless rather than periodic. Such a *Weltanschauung* is fortified, perhaps, by our ever-increasing mania for advanced technologies and artificiality, together with a concomitant alienation from nature itself (whose modalities are most often cyclical).

In contradistinction to modern Europe, the ancients and so-called 'primitive' non-Western civilizations preserved their intimate ties with the Cosmos: by remaining quite responsive to the periodicities and phases of celestial bodies, to Earth's seasons (which are absolutely central to any agrarian society), to its sea's tides, and even to biorhythms, such cultures apparently maintain a view of time as cyclic and non-developmental – as a type of eternity which seems to halt linear temporal progress by dilating it into infinity, to render it forever circular:⁵

... Many non-European cultures have produced predominantly nonlinear music, reflecting nonlinear cultural attitudes and life styles.

In Bali, for example, temporal processes are not linear. Balinese calendars are not used to measure duration. Rather, they are marked by ten concurrent cycles (of differing social meanings and degrees of importance) of from one to ten days in

length. The name and character of a day are determined by its place in the more important cycles, of five, six, and seven days respectively. Thus, Balinese time exhibits a circular quality: primary cycles repeat after 5, 6, 7, 30 (5×6), 35 (5×7), 42 (6×7), and 210 ($5 \times 6 \times 7$) days.

The cycles and supercycles are endless, unanchored, uncountable, and, as their internal order has no significance, without climax. They do not accumulate, they do not build, and they are not consumed. They don't tell you what time it is; they tell you what kind of time it is.

Only with great difficulty can the cycles of the Balinese calendar be translated into the periods of our calendars.

Balinese music, not surprisingly, is also nonlinear. It contains rhythmic cycles which repeat seemingly (to Western ears) without end, but the Balinese [people] do not think in terms of specific durations to be filled by "meaningful" events. Balinese music, like Balinese life, is not oriented toward climax. Activities in Bali are understood and appreciated not as means towards goals but rather as inherently satisfying in themselves. Thus it is not surprising that Balinese musical performances simply start and stop but have neither beginning gestures nor ultimate final cadences.

The Trobriand Islands, not far from Bali, also have a nonlinear culture. The language of the Trobrianders contains few words that communicate ideas of progress, change, becoming, or continuity. ... There are no words for comparison. There are no tenses. ... linear behavior, when it does occur [in their culture], is despised. Patterned sameness, not progressive change, is valued by the Trobrianders.

There are many other peoples whose time conception is not linear – south Indians, many tribes in Africa, the Hopi in the American Southwest, the inhabitants of Java, the Quiché Indians of Guatemala. What are we to make of these cultures from different parts of the world, each of which seems to put little value on some of our most accepted and comfortable concepts? It is ethnocentric simply to dismiss them as primitive. Many are highly developed civilizations with long and rich cultural heritages. Their pervasive acceptance of nonlinearity might tend to devalue the very idea of an inherited tradition, but nonlinearity does imply permanence. The existence of such cultures proves that temporal linearity is not a necessary component of human existence but rather a cultural creation: a magnificent and fruitful creation, to be sure, but nonetheless artificial. Nonlinearity is equally arbitrary: time is not an absolute reality. Rather, it means different things to different peoples. Thus, it is hardly surprising that various cultures' musics treat time differently.⁶

Yet Western rituals and sacraments (like the Eucharist) not only celebrate but may impel their participants to actually *experience anew* incidents long past which have been suffused with holy significance: some relic of time-circularity still endures within the Western psyche to confer promise that, culturally (and hence musically), temporal teleology and cyclicity might not be irreconcilable states after all. Indeed, the compossibility of such non-linearity with linear goal-directedness is substantiated, I believe, by at least two of my compositions within **A World of Becoming – Arcturus Timespace** and **Cycles of Vega**.

Cyclicity: Time-Perception and Meanings

At this juncture, it proves necessary to discriminate between long- and short-range repetitive time-cycles: the latter span merely a few seconds, and, typically, are able to be held *entirely* within one's very-short-term memory; the former simply cannot be remembered holistically – for each cycle may last up to several minutes. Certain composers and music theorists, such as Jonathan D. Kramer, contend that cyclical structures and compositional procedures (most particularly ones which are best described as short-range, like those normally encountered in minimalist or repetitive-process musics) can effectuate altered perceptions of time, to induce a sense of eternal stasis, of glacial timelessness or 'vertical time' ... an everlasting nowness.⁷

Aside from the second section from my **Solar Dust: Orbits and Spirals**, though, I have judiciously eschewed, throughout my compositional *œuvre* to date, all manner of *short-range repetitive rhythmic time-cycles* and other minimalist gimmicks (which, on the whole, I frankly consider to be rather dubious, being of little intellectual or artistic value). However, their *long-range* counterparts do seem to me worthwhile; they affect time-perceptions quite differently – to toy with one's memory – and thereby win some merit. In both **Arcturus Timespace** and **Cycles of Vega**, lengthy time-cycles are orbited through just three times. Will their cyclicity be heard? Does one consciously register any repetition? If so, when? My own impression is that only during their third occurrence – and not before – might a listener detect such extensive time-cycles' reiterations.

But beyond mnemonic affairs and the cognition of colotomic networks, what do a composition's repetitive time-cycles actually signify? They are, as I have already implied above, reminiscent of the Cosmos – of its heavenly periodicities, orbits and rotations (including their terrestrial consequences), as well as its living creatures' biological cycles. Yet non-teleological cyclicity – such as one might relish in the sounding of the biggest gong's regular colotomic return within the *gamelan* musics of Indonesia, within Sumatran *talempong* music, or within many other Asian musics besides – also invokes 'sacred time', a kind of timeless eternity, an overstep beyond secular 'clock-time' (one perhaps undergone during some holy ritual) ... as in the reliving of an epiphany. Cyclic music of this nature is truly a 'Music of the Spheres', equating to mystical things whereby one stands in awe of the infinite. Music consisting of unalloyed recurrent time-cycles – my piece **Zodiac: Crystal Orbit Improvisations** is one such example, with its various pitch-cycles and -epicycles – just 'starts and stops', as if it were a tiny slice of some perpetual process against which a human being's life-span is cosmologically negligible:⁸ so, finite cyclicity may indeed succeed in tapping into infinitude, and thus acquires fathomless meaning.

Repetitive Cyclicity and Epicyclicity in Cycles of Vega

As its very name intimates, cyclical constructs within **Cycles of Vega** are a prominent attribute of this composition: several formal levels therein appertain to the cyclic organization of duration, pitch, and timbre. Indeed, the privileging of timbre and temporality in particular as structural determinants is highly characteristic of **Cycles of Vega**; traditional harmonic- and pitch-syntaxes carry relatively little weight in moulding its form.

Cycles of Vega

... is intended to be a ‘companion piece’ to an earlier work of mine: **Echoes/Fantasies** (1984), for bass clarinet, vibraphone(s) and tubular bells. Both of these compositions make use of various complex long-range cyclic transformations – hence the present work’s name – as well as embracing related musical materials and structures. [The systematic permutation of temporal data is yet another common factor which allies both pieces.]

The title “Cycles of Vega” makes oblique reference to my longstanding astronomical interests. Vega (α Lyrae), the brightest object in the ‘musical constellation’ Lyra, will become the Earth’s north celestial pole-star sometime around 14,000 AD – since Earth’s polar axis inexorably describes, or cycles through, a vast circle in the sky every 25,800 years or so. Considered to be the greatest astronomer of antiquity and the founder of systematic observational astronomy, Hipparchos of Nicaea (fl. 146–127 BC) was allegedly the discoverer of this diuturnal cosmic process (referred to as ‘precession’)⁹ – although an explanation of precessional behaviour was not forthcoming for at least another 1,800 years, with the advent and codification of Newtonian mechanics! (Rotating bodies then perhaps began to be understood, a little...) At any rate, the (epi)cyclicity discernible within **Cycles of Vega** is certainly a ‘precessional metaphor’. Intended to proclaim our Universe’s grandeur, I trust that **Cycles of Vega** is not just some lifeless ‘acoustical orrery’, but is, rather, a truly vibrant model of the Cosmos it extols.¹⁰

But beyond the omnipresence of time-cycles in **Cycles of Vega** symbolizing cosmic or precessional periodicities, to a lesser extent I also bore in mind their potential to evoke certain recurrent (short-range) sound-patterns that one might hear within some natural ecosystems – such as the quasi-repetitive calls of birds and insects in the Australian bush. Yet it does seem rather unlikely that even the most attentive of listeners will be able to *consciously* register all of the layers of cyclicity within **Cycles of Vega** (although, for the sake of subliminal efficacy, these cyclical strata really do need to be indwelling).

At any rate,

the intricate structural hierarchies woven into **Cycles of Vega** could perhaps be interpreted as an (admittedly gross) simplification, essence, sign, or symbol of the infinite architectonic nature of God’s Universe.¹¹

Cycles of Vega’s macrostructure is essentially founded upon the systematic permutation of an ‘ur-set’ of twenty-nine durations; it falls into three sections (bars 4–35, bars 40–177, and bars 180–214) together with a brief introduction, two bridge-passages,

and a codetta – at bars 1–3, bars 36–39, bars 178–179, and bars 215–218, respectively. All three sections have been formulated isorhythmically, and their various isorhythms are also tintured with some *isochromata* and *isomeloi*.

Nevertheless, the sections themselves are abstractly interrelated, in that they each utilize, for their temporal basis-materials, the durational ur-set and its cyclic group of permutations. Across every section, however, such materials have been deployed quite variedly, with fresh musical data being introduced throughout by the e♭-clarinet part.

The long-range time-cycles upon which **Cycles of Vega**’s sections are built also contain shorter time-cycles (i.e. epicycles) within them – ‘wheels-within-wheels’, just like an orrery – to partially generate this work’s microstructure: one example of such an epicycle may be discerned in the pitch-organization of the e♭-clarinet part during the first section, wherein a sequence of sixteen pitches (played five times) churns smaller self-contained subsets of three or four pitches amongst themselves.

Cycles of Vega’s durational ur-set – I shall henceforth call it R, for ‘rhythm’ – possesses twenty-nine elements; these elements consist of time-spans which are whole-number multiples of a ♪ *chronos protos*, along with a handful of ‘tuplet’ rhythmic values (i.e. triplets, quintuplets, and septuplets):

R’s ordinal numbers:	1	2	3	4	5	6	7	8	9	10
their durations: *	4.♪	6.♪	1.333.♪	5.667.♪	8.♪	3.♪	2.♪	12.♪	1.♪	3.2.♪
R’s ordinal numbers:	11	12	13	14	15	16	17	18	19	20
their durations: *	20.4.♪	6.4.♪	2.♪	7.♪	4.571.♪	1.143.♪	12.857.♪	3.429.♪	2.♪	5.♪
R’s ordinal numbers:	21	22	23	24	25	26	27	28	29	
their durations: *	2.♪	3.♪	2.667.♪	18.333.♪	10.♪	7.♪	11.♪	14.♪	9.♪	

* NB: certain ‘irrational’ durations’ values herein – i.e. every one of those time-spans involving triplets or septuplets – have been rounded off to three decimal places.

R was then permuted by ξ , where

$\xi = (1, 2, 20, 19) (9) (5, 29) (6, 7, 27, 25, 8, 28, 26) (3, 21, 23, 13, 24, 14, 4, 22) (10, 12, 11) (15, 18, 17, 16).$

Now ξ ’s cycles were by no means designed haphazardly, for certain musical exigencies dictated the painstaking disposition of numbers between parentheses. I have already stated above that R includes small subsets of ‘tuplets’ – triplets {3, 4, 23, 24}, quintuplets {10, 11, 12} and septuplets {15, 16, 17, 18}. These subsets of R cannot be arbitrarily intermingled amongst different types of ‘irrational’ values (septuplets among triplets, for

example) or even amongst durations divisible by a ♪ *chronos protos* when two or more rhythmic layers have been superimposed and gridded together by a single system of bar-lines – as is the case with **Cycles of Vega**’s percussion parts: the notational (let alone performative) problems would otherwise be almost insurmountable. Hence throughout **Cycles of Vega**, such discrete groupings of ‘irrational’ durations are, of necessity, permuted by ξ in such a way that they only ever circulate amongst themselves, like *epicycles* – thus giving rise to three of ξ ’s cycles: (3, 21, 23, 13, 24, 14, 4, 22), (10, 12, 11), and (15, 18, 17, 16). R’s residuum of durations – all being straightforward multiples of ♪s – are able to be rather more freely permuted, epicyclically, by ξ , with considerably fewer constraints.

In addition to choosing permutations straight from the cyclic group $\langle \xi \rangle$ – whence there is a menu of 168 permutational possibilities – I also opted to work with the seven cycles of ξ *independently of each other*, to yield twenty-nine distinct epicyclic ‘subpermutations’ of R: just like the production of recombinant DNA, these ‘subpermutations’ (each of them arising from one of ξ ’s individual cycles) may then be sequenced together in order to synthesize lengthier rhythmic chains as required. (Such catenae of durations shall eventually constitute the long-range isorhythmic cycles inhabiting each of **Cycles of Vega**’s three sections,¹² whose isorhythms therefore evince a *double* cyclicity – permutational as well as repetitive.)

ξ ’s ‘subpermutations’ – which extract durational epicycles from R – are:

‘Subpermutations’ of ξ	<i>Chronos Protoi</i>	Epicycle Spans	‘Subrhythms’ of R: R_k , $1 \leq k \leq 7$
$\xi_1 = (1, 2, 20, 19)$	♪	17 ♪	$R_1 = (\xi_1)^0 = [1, 2, 19, 20]$
$\xi_2 = (9)$	♪	1 ♪	$R_2 = (\xi_2)^m = [9]$, for all $m \in \mathbb{N}$
$\xi_3 = (5, 29)$	♪	17 ♪	$R_3 = (\xi_3)^0 = [5, 29]$
$\xi_4 = (6, 7, 27, 25, 8, 28, 26)$	♪	59 ♪	$R_4 = (\xi_4)^0 = [6, 7, 8, 25, 26, 27, 28]$
$\xi_5 = (3, 21, 23, 13, 24, 14, 4, 22)$	♪; third of ♩	42 ♪	$R_5 = (\xi_5)^0 = [3, 4, 13, 14, 21, 22, 23, 24]$
$\xi_6 = (10, 12, 11)$	♪; fifth of ♩	30 ♪	$R_6 = (\xi_6)^0 = [10, 11, 12]$
$\xi_7 = (15, 18, 17, 16)$	♪; seventh of ♩	22 ♪	$R_7 = (\xi_7)^0 = [15, 16, 17, 18]$

With Olivier Messiaen, I concur that

... rhythmic music is music that scorns repetition, straightforwardness and equal divisions. In short, it’s music inspired by the movements of nature, movements of free and unequal durations. ...¹³

Cycles of Vega: Isorhythms
(a) Isorhythms within Section One (bars 4–35)

Section one from **Cycles of Vega** is precisely 120 ♩s in length. The percussion parts here comprise four articulations of a basal rhythmic cycle – an isorhythm – whose duration is 30 ♩s. The e♭-clarinet part within this section has likewise been formulated on cyclical principles: its isorhythm lasts 24 ♩s, and so must be played through five times in order to fill out the 120-♩ span of section one. All of the parts proceed concurrently through their own particular isorhythmic cycles, with their colotomies synchronizing only at the boundaries of this section (rehearsal letters A and E). The temporal mesoform of section one – as delineated by its colotomies – is, therefore, a quintuplet ‘hyperhythm’ (in the ratio 5:4):

$$\text{e}\flat \text{ clarinet: } 5 \times 24 \text{ ♩s} = 120 \text{ ♩s};$$

$$\text{percussion: } 4 \times 30 \text{ ♩s} = 120 \text{ ♩s}.$$

E♭ CLARINET			PERCUSSION		
Cycle	♩s	Bars	Cycle	♩s	Bars and Rehearsal Letters
1	1–24	4–10	1	1–30	4–11; A to B
2	25–48	10–16	2	31–60	12–19; B to C
3	49–72	16–23	3	61–90	20–27; C to D
4	73–96	23–29	4	91–120	28–35; D to E
5	97–120	29–35			

The percussion parts’ chronomorphology in section one springs purely from ξ’s aforementioned ‘subpermutations’. Since none of these ‘subpermutations’ happens to span exactly 30 ♩s (the length of the percussion isorhythm here), I was compelled to choose ‘subpermutations’ of various lengths and then splice them into one another such that their combined durations totalled 30 ♩s. The resultant isorhythm accommodates four layers of ‘subpermutations’ which I marshalled together under one system of bar-lines, thence conflated into a single rhythmic line:

Section One (percussion)	Layer	‘Subpermutations’	Spans
	I	$R_2 \cup (\xi_4)^5$	$1 \text{ ♩} + 59 \text{ ♩} = 60 \text{ ♩} = 30 \text{ ♩}$
	II	$(\xi_1)^2 \cup (\xi_5)^6 \cup R_2^*$	$17 \text{ ♩} + 42 \text{ ♩} + 1 \text{ ♩} = 60 \text{ ♩} = 30 \text{ ♩}$
	III	$R_3 \cup (\xi_5)^4 \cup R_2^\dagger$	$17 \text{ ♩} + 42 \text{ ♩} + 1 \text{ ♩} = 60 \text{ ♩} = 30 \text{ ♩}$
	IV	$R_6 \cup \xi_6$	$30 \text{ ♩} + 30 \text{ ♩} = 60 \text{ ♩} = 30 \text{ ♩}$

* Within layer II here, $R_2 = [9]$ was inserted after duration 21 from $(\xi_5)^6$.

† Within layer III here, $R_2 = [9]$ was inserted after duration 29 from R_3 .

However, the tabulated ‘subpermutations’ above were not simply conjoined in succession, but rather more intricately – according to a premeditated law. This law insists that R (i.e. my original ordering of twenty-nine durations), and its unpermuted ‘subrhythms’ R_1 to R_7 , will decree the correct manner whereby all ‘subpermutations’ are to be interleaved. By way of illustrating just how my ‘rule of subpermutational interconnectedness’ operates within **Cycles of Vega**, I shall now dissect layer II, in detail:

$$\text{Layer II: } (\xi_1)^2 \cup (\xi_5)^6 \cup R_2.$$

$$(\xi_1)^2 = [20, 19; 2, 1].$$

$$R_1 = [1, 2; 19, 20].$$

$$(\xi_5)^6 = [4, 24; 21, 13; 22, 14, 3, 23].$$

$$R_5 = [3, 4; 13, 14; 21, 22, 23, 24].$$

$$R_2 = [9].$$

In my sketch materials to **Cycles of Vega**, I have characterized R_2 – a lone ♪ *chronos protos* – as a “wanderer”, evidently alluding to celestial wanderers such as comets and planetesimals. NB: The Ancient Greek word *πλανητής*, *planētēs* (whence our English term ‘planet’), also means ‘wanderer’ – i.e. a zodiacal wanderer amongst the seemingly fixed stars. So $R_2 = [9]$ may be deployed freely, then, wherever I deem it to be musically most suitable, among any other ‘subpermutations’.

$$R_1 \cup R_2 \cup R_5: [1, 2; 3, 4; 13, \mathbf{9}, 14; 19, 20; 21, 22, 23, 24].$$

$$R_1 \quad R_5 \quad R_5, \mathbf{R}_2 \quad R_1 \quad R_5$$

$$\text{Layer II: } [20, 19; 4, 24; 21, \mathbf{9}, 13; 2, 1; 22, 14, 3, 23].$$

$$(\xi_1)^2 \cup (\xi_5)^6 \cup R_2: (\xi_1)^2 \quad (\xi_5)^6 \quad (\xi_5)^6, \mathbf{R}_2 \quad (\xi_1)^2 \quad (\xi_5)^6$$

Within the fifth bar of layers II and III from the percussion parts’ isorhythm, though, a relatively minor symmetry-breaking modification was made – for the sake of musical enhancement. Moreover, this isorhythm’s colotomy – heard at the start of bars 4, 12, 20 and 28 – is highly conspicuous ... to the ear as well as to the eye (in concert): an aggressive rasping sonority, a violent glissando whipped up by rapidly sweeping the hard wooden ball of a vibraslap across a vibraphone’s aluminium resonator-tubes (a technique which is, I believe, unique to **Cycles of Vega**). Each isorhythmic cycle also culminates in the distinctive timbral patina of a herd-bell windchime.

The isorhythm that underprops the *el*-clarinet part throughout section one from **Cycles of Vega** is in no way elicited from R, from ξ , or from any of ξ ’s seven ‘subpermutations’: rather, I composed a supplementary, utterly uncognate rhythmic pattern, spanning 24 ♪s but subdivided into (17 + 20 + 11) ♪s on account of its interior *isomeloi*; it is cycled through

five times in all. Also, a quite striking multiphonic trill-portamento flags the colotomy of each of the e \flat clarinet's 24- ♪ isorhythmic cycles (in bars 4, 10, 16, 23 and 29).

(b) Isorhythms within Section Two (bars 40–177)

Section two is by far the lengthiest structural unit within **Cycles of Vega**; its isorhythm (orbited through thrice, with colotomies at bars 40, 86 and 132) spans forty-six bars, and so is considerably longer than those from sections one or three. However, its morphology is commensurately simpler: the percussion parts in section two encompass just a pair of rhythmic lines, superimposed – R against ξ . (No ‘subpermutations’ of ξ or ‘subrhythms’ of R manifest themselves separately here: one intuits the absence of permutative epicyclicity.) Each isorhythmic cycle lasts 188 ♪ s, ending – as so much indigenous music from Asia also does – with a stroke of the tam-tam (in bars 85, 131 and 177):

Section Two (percussion)	Layer	Permutations	Spans
	I	$R \equiv \xi^0$	188 ♪
	II	ξ	188 ♪

Although the e \flat -clarinet part's temporal design yields no intimate relation to this percussion isorhythm or to ξ 's permutivity, it is nevertheless cleft into three subsections – for concision, I shall tag them A, B, and C – whose lengths match the isorhythm's 188 ♪ s. The e \flat clarinet's rhythmic details within subsections A and B likewise bear little resemblance to one another, whereas subsection C is essentially an ‘accumulation’ of the previous two subsections: here, this ductile aggregative process applies to both duration- and pitch-materials.¹⁴

(c) Isorhythms within Section Three (bars 180–214)

Section three embraces several epicyclic ‘subpermutations’ (intermingled in conformity with the same ‘law’ as was used in section one) to engender, within the percussion parts alone, its three strata of isorhythms: two of these time-cycles span 22 ♪ s and are circled through three times; the third layer, composed solely for the *rin*, traces out a different pattern – a 17- ♪ isorhythm spun out thrice, but concluding with three attacks whose metallic resonances traverse 15 ♪ s. So, aside from the processually interruptive bar 208,¹⁵ these three interwoven isorhythmic lines cover exactly 66 ♪ s (from bar 180 to bar 213); bar 214 is merely a prolongation of this section's final sonority.

The blending of those ‘subpermutations’ which I have engaged within section three is shown below in a table. As before, the various isorhythmic layers have been mustered under a single system of bar-lines, thence fused together into one conglomerate rhythmic ‘cable’:

Section Three (percussion)	Layer	‘Subpermutations’	Spans
	I	$((\xi_7)^3 \cup (\xi_7)^2) \times 3$	$(22 \text{ ♩} + 22 \text{ ♩}) \times 3 = 132 \text{ ♩} = 66 \text{ ♩}$
	II	$((\xi_5)^2 \cup R_2 \cup R_2) \times 3 *$	$(42 \text{ ♩} + 1 \text{ ♩} + 1 \text{ ♩}) \times 3 = 132 \text{ ♩} = 66 \text{ ♩}$
	III	$((\xi_1)^3 \cup \xi_3) \times 3 \cup (\xi_6)^2 \dagger$	$(17 \text{ ♩} + 17 \text{ ♩}) \times 3 + 30 \text{ ♩} = 132 \text{ ♩} = 66 \text{ ♩}$

* Within layer II here, $R_2 = [9]$ – i.e. the ‘wandering’ *chronos protos* – is twice inserted into $(\xi_5)^2$ thus: [..., 22, **9**, 13, **9**, 21, ...].

† During the third cycle of the isorhythm $(\xi_1)^3 \cup \xi_3$, durations 1 and 29 were each adjusted by 1 ♩ – in order to sidestep a literally repetitious, simplistic rhythm which would otherwise have occurred locally. Layer III is assigned to the *rin* alone.

Viewing **Cycles of Vega**’s macroform *in abstracto*, one might now be able to appreciate a loftier epicyclicity: beyond the probability that sections one and three (being somewhat briefer) will be regarded as ‘satellites’ of the central section two, epicyclicity is also intrinsic to both of these sectional ‘moons’, whose temporal genetics consist in ξ ’s ‘subpermutations’; section two’s chronomorphology, on the other hand, is constituted from entire cycles of R and ξ .

Cycles of Vega: *Isochromata*

Cycles of Vega’s percussion instrumentarium is truly unique: it

... includes twenty(!) varieties of windchime, seven *rin* (Japanese temple bells) and tubular aluminium sound-sources that I have constructed and assembled myself (“Shan Tubes”), as well as a number of other metallic percussion instruments.¹⁶

Except for the *rin*, crotales, vibraphone and cowbells (all of which are quite pitch-specific), every other percussion instrument employed throughout **Cycles of Vega** is, relatively speaking, unpitched – thereby negating somewhat the rôle of pitch as a formal determinant within this composition. (Furthermore, the stochastic character of the windchimes’ sonic spectra does impart some degree of local unpredictability.) Indeed, the exotic, hothouse sound-world of **Cycles of Vega** is a significant attribute of the piece:

... I try to evoke, within the sound-world of **Cycles of Vega**, an extremely unearthly, timeless, cosmic, astral state. In large part, this is achieved through the use of a rather unusual (even idiosyncratic) instrumentation ... [whose] microtonal tunings, and the [piccolo] clarinet’s technical treatment in general, additionally indicate an attempt on my part ‘to look ahead’ musically and aesthetically, liberated from the artificial restrictions of the past. ...¹⁷

Cycles of Vega's three sections are each tinged, in their own way, by a mindful demarcation of percussion instruments (together with the mutually exclusive sectional deployment of certain distinctive timbres issuing from the *e♭* clarinet). By analogy with **Cycles of Vega's** temporal cyclicity, the organization of timbre in **Cycles of Vega** is likewise overwhelmingly cyclical: many percussive sonorities act as 'timbral anchors' whereby, within some isorhythmic layer, their order and affinity with a specific duration remains utterly frozen – to furnish *isochromata*; for other timbres, though, the timing of their onset relative to an isorhythm's colotomy is mutable.

Eo ipso, an *isochroma* will only ever collocate a fixed array of timbres, which may commingle strictly amongst themselves. Moreover, the time-span of each *isochroma* in **Cycles of Vega** always equates to that of its supporting isorhythm: their colotomies invariably match one another, to curb any 'phasing' effects.

(a) *Isochromata within the Percussion parts, Section One (bars 4–35)*

My approach to percussive timbres within **Cycles of Vega's** first section was fundamentally statistical: twelve such colours – brittle, granular windchime sounds, lush sleighbell rattles, cymbal splashes and curt cowbell 'clonks' – are brought forth, and the number of times one hears each percussion instrument per isorhythmic cycle is, mostly, kept constant.¹⁸ Yet whilst the majority of durations from every isorhythm here are assigned divergent timbres between cycles (such that my instrumental palette, being invariant, merely re-orders its colours), nearly half of my isorhythmic durations retain exactly the same timbres throughout this section – a unifying feature amidst its kaleidoscopic diversity, surely – to breed *isochromata*. (The vibraslap in particular flaunts an extreme isochromalism: whenever it is called for, it *always* belongs to some *isochroma* – being allocated to the very same durations within every isorhythmic cycle.)

The table below unveils the first section's *isochromata*:

Percussion Instrument Abbreviations – Section One (bars 4–35)

Colot. = colotomy {'vibraslap glissando'}

Cowb = cowbells

ShW = shell-disc windchime

Vbslp = vibraslap (played normally)

WW = wooden-rod windchime

Sleigh = sleighbells

BaW = bamboo-tube windchime

SUW = sea-urchin-spine windchime

HW = herd-bell windchime

NB: — = a *variable instrumentation* (although for certain of these durations here, within three out of their four isorhythmic cycles they have been matched to precisely the same timbre, thereby rendering them quasi-isochromal). Moreover, any durations whose numbers below are underlined have undergone some sort of minor alteration.

Layer									
I	R duration-number	9	28	26	27	7	8	6	25
	Instrument	Colot.	Cowb 3	ShW 1	Vbslp	WW 1	Sleigh	BaW 1	SUW 1
II	R duration-number	20	19	4	24	<u>21</u>	<u>9</u>	<u>13</u>	2
	Instrument	Colot.	—	—	Vbslp	—	—	—	Vbslp
III	R duration-number	24	23	5	22	<u>21</u>	<u>14</u>	13	4
	Instrument	—	ShW2 *	—	—	—	—	—	—
IV	R duration-number	10	11	12	12	10	11		
	Instrument	Colot.	—	—	—	—	—		

Layer						
II	R duration-number	1	22	14	3	23
	Instrument	—	Cowb3,4	—	—	Cowb4,3
III	R duration-number	3	29	9		
	Instrument	—	—	HW		

* NB: during the initial isorhythmic cycle, the windchime here is instead **SUW 2** – this being a late change that I made within **Cycles of Vega**'s score (despite its sketch-materials).

(b) Isochromata within the Percussion parts, Section Two (bars 40–177)

Within section two from **Cycles of Vega**, the vibraslap and most of the 'drier'-sounding windchimes are noticeably absent (due to their prominence within section one). **Cycles of Vega**'s second section – much more than its first – is, however, predominantly isochromal: all but a few isorhythmic durations here do maintain their linkage to a particular timbre, while the handful of exceptions serve mainly to tint each subsection ever so slightly:

Percussion Instrument Abbreviations – Section Two (bars 40–177)

Crot = crotales

Rin = *rin*

Cowb = cowbells

BrTW = brass-tube windchime

Vib = vibraphone

ShTL = large-diameter "Shan Tubes"

KBT = "Kenyan bell tree"

ShTS = small-diameter "Shan Tubes"

BrDW = brass-disc windchime

CW = ceramic-disc windchime

NB: — = a *variable instrumentation* (although for certain of these durations here, within two out of their three isorhythmic cycles they do correspond to exactly the same timbre, thereby rendering them nearly isochromal). Furthermore, any durations whose numbers below are underlined have undergone some sort of minor modification.

Layer									
I	R duration-number	1	2	3	4	5	6	7	8
	Instrument	Crot	Rin	Cowb 3, BrTW	Rin 2	Vib	ShTL	Rin 7, 6	Vib
II	R duration-number	2	20	21	22	29	7	27	28
	Instrument	Vib	ShTL, S	—	Crot	Vib	ShTS	Rin 1	Cowb, Vib
Layer									
I	R duration-number	9	10	11	12	13	14	15	16
	Instrument	KBT	ShTS	ShTL	BrTW, ShTL	ShTS	Vib	Rin 4	Cowb 1
II	R duration-number	9	12	10	11	24	4	18	15
	Instrument	BrDW	Vib	Rin	Crot	Vib	Rin 6	Vib	—

Layer									
I	R duration-number 17 Instrument	Vib	18 Crot	19 ShTL	20 Vib	21 —	22 Rin 4, ShTS	23 —	24 Vib, Rin
II	R duration-number 16 Instrument	ShTS	17 Crot	1 ShTS	19 ShTL, CW 2	23 Vib	3 —	<u>13</u> —	<u>14</u> Rin

Layer						
I	R duration-number 25 Instrument	Crot, Cowb 1	26 —	27 —	28 Rin 1 *	29 Rin 5
II	R duration-number 8 Instrument	Vib	6 Cowb 4	25 Vib	26 ShTL *	5 Vib

* NB: during the third isorhythmic cycle here, these two timbres' attacks have been postponed slightly.

(c) *Isochromata within the Percussion parts, Section Three (bars 180–214)*

The soundscape of **Cycles of Vega**'s third section is eclipsed by the sparkling metallic sounds of the vibraphone, crotales, and *rin* (with triangles, an autocoil, and the cymbals also making their presence felt). Only the top two isorhythmic layers here exhibit any *isochromata*; the third layer – which I shall omit from the table below, since it encompasses no *isochromata* – is reserved exclusively for the seven *rin*.¹⁹ As was the case with section one, rather less than half of the isorhythms' durations here are isochromal:

Percussion Instrument Abbreviations – Section Three (bars 180–214)

Ch = large Chinese cymbal
Rin = *rin*

Vib = vibraphone
Crot = crotales

NB: — = a *variable instrumentation* (although for certain of these durations here, within two out of their three isorhythmic cycles they map to the very same timbre, thus rendering them almost isochromal).

Layer									
I	R duration-number 16	17	18	15	17	18	15	16	
	Instrument Ch	Rin, Vib	Rin	Crot	—	Vib	—	Crot *	
II	R duration-number 23	3	14	22	9	13	9	21	
	Instrument Vib	—	—	—	Vib	—	—	—	
Layer									
II	R duration-number 24	4							
	Instrument —	—							

* NB: during the final isorhythmic cycle here, the highest crotales's attack has been delayed until bar 214.

Cycles of Vega: *Isomeloi* (a) *Preamble – On Pitch*

Unlike **Cycles of Vega**'s cyclical chronomorphology, its pitch-structures are not the end-product of any sublime 'precompositional' or serial schemata. (Actually, from a

psychoacoustical standpoint, systemic pitch-edifices alone seem to me to be incapable of elucidating any but the most prosaic of foreground structures.) Nonetheless, a rather selective approach to clarinet fingerings did restrict the pitches available to me – thereby delivering to **Cycles of Vega** a natural ‘tuning system’ upon which its e \flat -clarinet part was established.

My ongoing exploration of ‘extended woodwind techniques’, as well as **Cycles of Vega**’s incorporation of *recherché* percussion instruments, demanded a fresh appraisal of pitch as one amongst several compositional parameters: by utilizing throughout **Cycles of Vega** many windchimes and other ‘unpitched’ percussion, microtonally tuned *rin*, and my home-made “Shan Tubes”, I was automatically bound to the immutable sounds which proceed from such instruments. **Cycles of Vega** is, therefore, securely underpinned by the singular, immanent intonations generated by my own instrumentarium and preferences in clarinet performance techniques; within such an introspective compositional milieu, discriminations between ‘pitch’ and ‘timbre’ can often become slim indeed.

Sometimes, accessible pitches on the e \flat clarinet were foreordained by technical exigencies: I originally envisaged **Cycles of Vega** being performed in concert by just two executants – a sole percussionist, and an adventurous clarinetist who also happens to activate certain percussion instruments simultaneously with the e \flat clarinet at designated places in the music. Hence within my sketches to **Cycles of Vega**, I synthesized (from various sources) numerous charts showing those “single-hand resources” which are accomplishable upon an e \flat clarinet; many of their fingerings and resultant pitches – all entailments of clarinet physiology and its Boehm fingering mechanism – have also been included within my score’s preface. The one-handed playing of any woodwind instrument will, to be sure, ration its quota of obtainable pitches quite severely, and this deliberately self-imposed inhibition *vis-à-vis* pitch certainly exercises considerable sway during the opening and closing sections of **Cycles of Vega**.²⁰ Even so, e \flat clarinet’s pitches in **Cycles of Vega** – taken either individually, or in groups – were targeted at any given moment as much for their innate timbres as for any underlying syntactical relationships between the tones themselves.

(b) *Isomeloi within the e \flat -clarinet part, Sections One and Three (bars 4–35 and bars 180–214)*


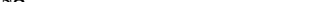

The e \flat clarinet throughout section one engages all twelve pitch-classes from the equal-tempered chromatic scale,²¹ within a hierarchy comprising two tiers of cyclicity. The primary isomelodic time-cycle corresponds to the e \flat clarinet’s 24- ♩ isorhythm, discussed

earlier, whose span I partitioned into (17 + 20 + 11) ♩s; its pitches map onto these three rhythmic segments, each of which is flagged by a dazzling timbral ‘epicolotomy’ – either a multiphonic trill-portamento (viz. the isorhythm’s colotomy), or a boisterous ‘extended technique’ (I recall contriving it to imitate the vibraslap’s chatter and envelope) which amalgamates random air-noises, fluttersong, key-vibrato, and key/finger-sounds. (Notice, too, that the fifth – and final – isomelodic cycle reprises the first cycle, verbatim.) On a secondary plane of pitch-cyclicity, four isomelodic epicycles operate within the primary *isomelos*: these epicycles encapsulate smaller pitch-cells, the first three of which also permute their elements unsystematically. The following table discloses the first section’s isomelodic data, but it totally excludes all of the e♭-clarinet *isomelos*’s grace-note pitches (whose rôle in this context is, I must confess, primarily decorative). The e♭ clarinet’s *isomelos* is:

Pitch: G♭4 D♭3 F♯5 B♭4 C♯3 A♭4 D♭3 C♯5 B♭4 E♭3 B♭3 F♯5 C♯5 F♯3 E♭3 A♭4
Number: 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16

M = multiphonic trill-portamento (colotomy);

V = an ‘ersatz vibraslap’ (random air-noises, fluttersong, key-vibrato, and key/finger-sounds).

♩ Spans:		17 ♩s 					20 ♩s 					11 ♩s 								
Cycle Bars		Epicycle 1					Epicycle 2			Epicycle 3		Epicycle 4								
I	4–10	M	1	2	3	V	4	5	6	7	8	9	10	V	11	12	13	14	15	16
II	10–16	M	2	1	3	V	6	5	4	9	10	7	8	V	11	12	13	14	15	16
III	16–23	M	1	2	3	V	5	6	4	10	8	9	7	V	11	12	13	14	15	16
IV	23–29	M	2	1	3	V	4	6	5	8	7	9	10	V	11	12	13	14	15	16
V	29–35	M	1	2	3	V	4	5	6	7	8	9	10	V	11	12	13	14	15	16

During section three of **Cycles of Vega**, the e♭ clarinet’s *isomelos* synchronizes, isochronously, with the percussion instruments’ isorhythm: their colotomies always coincide, and both cycles last 22 ♩s. Moreover, there are no isomelodic epicycles here, for each of the e♭ clarinet’s tones always retains the same duration, ordinality and octave-register upon every return of its *isomelos* – apart from a quite superficial variation in bars 197–199. It must also be remembered that the menu of available clarinet pitches was acutely limited by my original prerequisite that, throughout section three, the clarinettist had to play their instrument using only those fingering-patterns which employed their right hand alone, in order that they could also strike the seven *rin* with a wooden *rin*-beater held by their left hand. Notwithstanding, I was unremittingly vigilant in composing the e♭ clarinet’s pitches such that they would tastefully harmonize with the prevailing percussion sonorities.

1.2.3 STATISTICAL WEIGHTING OF PERCUSSION TIMBRES

Over a given time-span, if one has predestined both the instrumentation and the total number of attacks, then one is able to statistically apportion all of the available timbres, assigning various ‘weightings’ to each. This is a relatively simple matter of accountancy; it does not necessitate any reference to obscure mathematical formulae. Such *statistical weighting of timbres* deals in broad sweeps of numerical averages across sometimes lengthy durations: local colouristic evolutions are therefore ‘composed instinctively’, or are moulded according to some other schemata, so that over the whole period in question, a timbre’s statistical density (i.e. its number of attacks in each second) will ebb and flow. For this compositional technique, the attack-tally is foreordained either by some pre-existent rhythmic design or instead by deciding beforehand upon the average density of attacks per unit of time.

In the third section of **Cycles of Vega** (bars 180–214), the percussion parts have been preformed by conflating three isorhythmic layers that were generated through systematic permutation, one stratum of which is allocated solely to the seven *rin* (Japanese temple bells). This ‘*rin* layer’ comprises twenty-one attacks, wherein the seven *rin* are segregated into four pitch-cycles of 5 + 5 + 5 + 6 tones. The three 5-cycles call for only the six highest *rin*, whereas the final pitch-cycle summons the deepest *rin* as well, which is struck just once, in bar 205, at the beginning of this isorhythmic stratum’s longest duration; the seventh *rin* has also been granted the loudest dynamic level of all the *rin* within this 6-cycle, thereby spotlighting its timbre. The ‘statistical weighting’ of the seven *rin* here was predetermined so that there would be an audible bias towards the higher-pitched timbres:

RIN 1, 2 & 3 — 4 attacks each;

RIN 4 & 5 — 3 attacks each;

RIN 6 — 2 attacks;

RIN 7 — 1 attack only.

My surviving sketches for **Cycles of Vega** disclose traces of several other ‘statistical distributions of percussion timbres’ in this piece – but alas, the details have all been irrevocably lost: the only evidence that remains are some lists of percussion-instrument names, handwritten repeatedly, thence crossed out one at a time as each timbre was matched to an attack. Conversely, the sketch-material of **153 Infinities** is, at the time of writing, fully intact. It shows that, beyond the first second of this work’s brief deluge of percussion music, *all* of its percussion timbres are weighted statistically. One example shall suffice to demonstrate my compositional methods therein.

Over the mere thirty-five seconds through which the six percussionists play during **153 Infinities**, I elected to gradually rarefy their music by decreasing progressively its average density of attacks per bar. For “Percussion Zone 1” (percussionists 1 and 2; “God the Father”) in bar 4 (i.e. 14”–27”), I decreed that there would be an *average* density of almost four attacks per second over that bar’s thirteen seconds (yielding a total of fifty-one attacks in all), and that this percussion zone’s instrumentation during bar 4 would consist of a vibraphone, five almglocken, a large brake drum, a large Chinese cymbal, a large sizzle cymbal, a “triangle windchime”, an aggregation of brass-tube windchimes, and a “Kenyan bell tree”; meanwhile, I also resolved that the three windchime-like idiophones listed above would be agitated just once during this thirteen-second time-span. Hence, these instruments’ timbral weightings, in order of diminishing bias, are:

VIBRAPHONE — 24 attacks;
FIVE ALMGLOCKEN — 13 attacks;
LARGE BRAKE DRUM — 5 attacks;
LARGE CHINESE CYMBAL — 4 attacks;
LARGE SIZZLE CYMBAL — 2 attacks;
“TRIANGLE WINDCHIME” — 1 attack only;
BRASS TUBE WINDCHIME(S) — 1 attack only;
“KENYAN BELL TREE” — 1 attack only.

In general, for the majority of ‘unpitched’ idiophones in **153 Infinities**, their ‘statistical weightings’ then underwent further processing whereby their attacks were marshalled into a labyrinthine polyphony of rhythms derived from certain mathematical functions (which I shall explore in section 1.2.11).¹

The *protennoia* (‘primal thought’) that rules over the sonic landscape of **[p]s(t)ellor/mnême**, too, is statistical: each of its string-instrument parts is meted out a strictly invariant set of acoustic “objects” that, within every one of this work’s eleven sections, is sounded either just once, or perhaps not at all:

MANDOLA — 43 “objects”;
CELTIC HARP — 37 “objects”;
ALTO REBEC — 32 “objects”;
BASS VIOLA DA GAMBAS 1, 2 & 3 — 38 “objects” each.

And although the pitch-orderings within the handbells’ eleven peals in this piece are systematically permuted (a serial tactic that emulates the ‘changes’ of campanology), there remains a substratum of statistical thinking here as well: for all of their tintinnabulations, I prearranged it so that every one of the sixteen handbells would be rung exactly twice.

Even within my alto flute solo **Dimensiones Paradisi**, one can detect vestiges of statistical *modus operandi*. For example, excluding sections E and E' (as well as any grace-note groups), the other six “pale, lunar” multiphonic phrases always incorporate precisely four sustained multiphonics taken from a menu of seven multiphonics. Statistically, across all of these “pale, lunar” subsections, five of these seven multiphonics materialize four times, and the remainder thrice each. The following tabulation, adapted from my sketches, clarifies these statistics:

Multiphonic Menu	Sections							no. of times used
	A	B	C	E	E'	C'	B' *	
B \flat 3, E \flat 4	•					•	•	3
B \sharp 3, E \sharp 4		•		•		•	•	4
C \sharp 4, F \sharp 4, D \flat 5		•				•	•	4
C \sharp 4, D \sharp 4	•	•	•		•			4
C \sharp 4, E \sharp 4	•		•				•	4
C \sharp 4, G \flat 4, D \sharp 5	•		•			•	•	4
D \sharp 4, F \sharp 4		•	•				•	3

* NB: the “pale, lunar” multiphonics within section B' conclude with a fifth multiphonic that is foreign to this seven-multiphonic set.

The pitches within every one of the eleven sections A to F and E' to A' in **Dimensiones Paradisi** are scrupulously controlled by a Byzantine symmetrical system of *gamuts* (i.e. upper and lower extrema, beyond which pitches may not stray) that has been distilled mathematically from a mandala-like “generative symbol” of concentric geometrical shapes – an ‘outline of Paradise’. Each of these gamuts also contains a ‘subgamut’, similarly extracted from the same symbolic source, that instigates a slight ‘statistical bias’ upon pitches within the gamut. For instance, the first gamut in section A (which takes effect *immediately after* the “pale, lunar” multiphonics) is D \sharp 3 — C \sharp 5, with a ‘statistical bias’ towards the subgamut of pitches D \sharp 3 — F \sharp 4; the last gamut of this section is likewise D \sharp 3 — C \sharp 5, but its subgamut exerts a symmetrically opposed statistical preference for pitches within the range A \sharp 3 — C \sharp 5.² Anyway, the net global impact of all of these gamuts is that “because, conceptually, the Arrow of Time ‘cuts across’ the generative symbol, there is a statistical tendency imposed upon the material of **Dimensiones Paradisi** to rise, inexorably, as if to Heaven...”³ Nonetheless, I am intrigued by the fact that my progression of subgamut weightings is really a *virtual structure*, a one-way ‘trapdoor function’,⁴ a musical cypher that can never be *accurately* reconstructed in reverse simply by analysing pitch-propensities from within the score.⁵

1.2.4 PROPORTIONS AND MULTILEVEL ARCHITECTONIC SELF-SIMILARITY

*“Verum est ... quod superius est sicut quod inferius
et quod inferius est sicut quod superius,
ad perpetrando miracula rei unius.”*

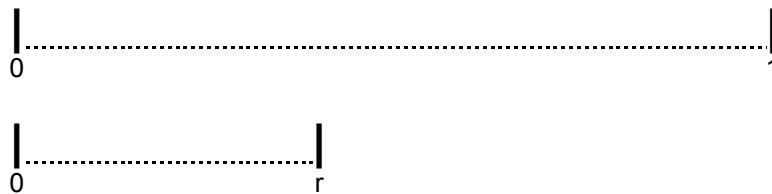
*It is true ... what is above is like that which is below
and what is below is like that which is above,
to accomplish the miracles of one thing.*

– Hermes Trismegistos [‘Thrice-Greatest Hermes’]: **The Emerald Tablet.**¹

It is the mark of the divine intellect to be always calculating something noble.

– Democritus of Abdera (5th century BC).

In music, one devises *proportions* by dissecting continuous segments from the time domain into *ratios*;² these temporal units can involve durations, pitches (viewed absolutely as frequencies, or intervallically instead),³ and even timbres.⁴ For the sake of simplicity, throughout section 1.2.4 I shall ‘normalize’ segments so that numerically they span the interval from 0 to 1.⁵ If such a continuum is to be partitioned according to some constant r (with $0 < r < 1$) –



– then the following possibilities for proportionality exist:

1. **0-alignment:**

A horizontal line segment from 0 to 1, with a vertical line at position r.

2. **1-alignment:**

A horizontal line segment from 0 to 1, with a vertical line at position 1 - r.

3. **concentricity:**

A horizontal line segment from 0 to 1, with vertical lines at positions $(1 - r) \div 2$ and $(1 + r) \div 2$.

4. **skewness:**

A horizontal line segment from 0 to 1, with vertical lines at positions $S(r) - r \div 2$, $S(r)$, and $S(r) + r \div 2$. A dot is placed at the position $S(r)$.

where $S(r)$ is the skew-constant of r , and $(r \div 2) < S(r) < (1 - r \div 2)$, with $S(r) \neq 0.5$.

In the ensuing discussion, I will concentrate solely upon the first case above. Now, let our unitary temporal continuum be proportioned by the n constants $r_1, r_2, r_3, \dots, r_k, \dots, r_n$

with $0 < r_1 < r_2 < r_3 < \dots < r_k < \dots < r_n < 1$. Then we inevitably obtain the $n+1$ ratios $r_1:(r_2 - r_1):(r_3 - r_2):\dots:(r_k - r_{k-1}):\dots:(r_n - r_{n-1}):(1 - r_n)$. Such a systematic – and, we shall learn, highly symbolic – engagement of proportions as a unificatory device is quite likely antediluvian:

The historian's preoccupation with the literary and mathematical remains of proportional theory, particularly with the suggestive but imperfectly documented traditions of the Pythagoreans, can easily overlook a fundamental point: that the origins of proportionate art ... are much older than philosophy and mathematics – older, probably, than writing itself. In the Egyptian hieroglyph for 'town', a circle enclosing a centrally located cross, we already find the essential geometry of urban form concisely expressed in the symbol or *mandala* which traditionally encoded the analogy of the macrocosm and the microcosm, and the idea of the city or temple as an *imago mundi*. The cosmic associations of the circle (symbolising heaven) and the square (symbolising earth) are found in all the old Eurasian civilisations, which must therefore be presumed to have shared this formative world-view. The high antiquity of these ideas is confirmed by the etymology of key technical terms, some of which take us back to the oldest root-stock of the Indo-European languages. For example, the root, (h)ar, is common to the Greek *harmonia*, the Sanskrit *rta* (world order) and the Latin *ritus* (whence the English terms, rite and ritual): these and many other related terms convey the notion of fitting together opposites, at all cosmic levels, into a balanced whole. The same world-view connects the root, tem, with *temenos* (the sacred circular space), *templum* (the divine house within the sacred space), *tempus* (perhaps expressing the image of time as circular) and apparently also *template* (which preserves the idea of an outline or analogical form). Closely related is the extensive vocabulary of tuning, words such as temper, temperance, temperament, which, as Leo Spitzer has shown, is employed throughout the cosmic hierarchy and widely diffused among the European languages. The distribution of this terminology alone demonstrates the cultural significance of ... proportion, especially *due proportion*, a concept deployed in most areas of human regulation and control, including ethics, law, politics, medicine, architecture and the polite and ornamental arts generally. The unifying principle here is music, whether in the concrete forms of human song and dance or in the more intellectual abstractions and cosmic associations of the vibrating string. ...⁶

In Graham Pont's discourse above, we are informed of one source of cultural meaning behind proportionality: the harmonization of diversities into some well-balanced unity (as well as the invocation of sacred space and time). Still, there are other sematological well-springs, too. Certain ubiquitous numbers that can be used to produce musical ratios – such as the well-known Golden Section constant $\Phi = ((\sqrt{5} - 1) \div 2) \approx 0.6180339887$, and the reciprocals of $e \approx 2.71828182845$, of $\pi \approx 3.1415926536$, of $\sqrt{2} \approx 1.4142135623$, and of $\sqrt{3} \approx 1.7320508075$ – possess inherent meaning because they are prototypic, in that they proceed from nature and its underlying geometrical patterns.⁷ Moreover, ever since Christianity's entanglement with Platonic philosophy during the earliest centuries of the Common Era,⁸ ratio – or *logos* – as a unifying force has regularly been equated to Jesus, the Divine Logos:⁹

... the universe, of which we all are a part, is a living whole: in some elusive way, all

the parts of creation are united within a greater unity, and this is something we tangibly sense whenever we are confronted with the experience of beauty. This realization of unity in diversity was one of the central concerns of the early Greek philosophers, and culminated in the Hellenistic idea of “the Logos”, which drew on the earlier Pythagorean views of harmony and proportion. As is well known, in the first centuries of the common era, Jesus was widely perceived and represented as the Logos – the cosmic power of Harmony, which was seen as underlying the order of the universe by some of the earliest Christians.¹⁰ In antiquity, the nature of the Logos was represented in many ways, but its most central emblem was the Sun, symbolizing the source of Reality, the source of Light and Life. Yet, in addition to the mystical approach, which is well documented in many surviving texts, the nature of the Logos was also studied in a scientific sense, long before the appearance of Christianity. One of the meanings of *Logos* is “ratio”, as in mathematical ratio: “the pattern which connects”, the principle of mediation between extremes, the conceptual link between one and many, unity and multiplicity. ...¹¹

The proportional ‘fitting together’ of complementarities into a holistic system is a *harmonia* that begets beauty, and is attained through creating ratio (or *logos*) via number and geometry. The unity behind multiplicity in such a cosmos has ratio as its binding mechanism; proportion generates this interrelational unity and is also a means of analysing it. (Indeed, unity revels in differences – an inspiring paradox!):

According to the Pythagoreans, the cosmos is made up of a dynamic harmony of opposites or complementary forces. In the same way that the year encompasses both winter and summer, night and day, so too is the universe a living harmony of opposing tendencies and forces. ... by applying the word *kosmos* to the universe, Pythagoras was saying that the earth and the heavens are adorned and ornamented by beauty. It implies that there is an order to the universe ... Pythagoras said that [our universe, the] *kosmos* is a *harmonia*, a “fitting together”. Developed in a mathematical sense by the Pythagoreans, the root concept of *harmonia* is truly primordial; the term *harmony* springs from the prehistoric (*circa* 5000 BC) Indo-European root *ar-*, “to fit together”, which is the root of the words ARM, HARMONY, ART, ORDER, ORNAMENT, ADORN, RATIO, REASON, READ, RITE, ARITHMOS (number), and RHYME. Through the principle of harmony, the parts fit together into the whole. Even though the universe contains an unlimited number of things, phenomena, and forces, they are all miraculously and beautifully reconciled into the greater whole. This is the law of “unity in multiplicity” which fascinates every careful observer of the natural world. In their philosophy, the Pythagoreans expressed these relationships through the natural language of number and geometry. Number is a natural language because, like the harmonic ratios in music, it is not invented, but discovered. However, the Pythagorean vision of Number is quite different from the way we imagine it today. While we use numbers to count things in a quantitative sense, the Pythagoreans saw Number as a *qualitative* essence, a principle of relationship or *logos*. ...¹²

As the Pythagoreans realized, the study of proportion and harmony constitutes an objective science and comprises the starting-point for a philosophy of whole systems. A philosophy of whole systems is based on the premise that there is an underlying unity behind the nature of things, and that the many parts of an organism are intrinsically related to one another within the context of a greater whole. This principle of relatedness is seen to exist inherently in the structure of the human body, the biosphere, and the structure of the solar system. A philosophy of whole systems recognizes this “fitting together” [*harmonia*] and trains the mind to see how the parts

relate to the whole; it helps us to think in terms of whole systems, leading our minds and our conceptions to follow the path of Nature itself. In order to achieve this type of “proportional thinking”, the ancient Pythagoreans both studied and exposed their intellects to the pure principles of geometrical and musical harmony, which are the most primeval types of natural relationship (*logos*), and thus underlie the more complex organic relatedness of phenomena in the natural world. A philosophy of whole systems starts with the realization that there is unity behind diversity, and that, in the manifest world, unity expresses itself through the differentiated image of multiplicity. This manifestation is controlled by the related principles of Number, Logos, and Harmony, as seen in the Pythagorean sense. ...¹³

How, though, does proportion effectuate unity within a composition? Music can be conceived structurally across various architectonic magnitudes of time: timbres/pitch-frequencies, individual sound-events, rhythmic cells or phrases, subsections, sections, movements, the whole piece ... and beyond – up to cycles of pieces. Hence some (or even all) of these formal tiers – such as a work’s sections and their subsections – might be proportioned in accord with the same set of numerical constants; *multilevel architectonic self-similarity* thereby emerges, and so we move ever closer to the unific ideal of ‘form’ and ‘content’ becoming one, wherein sound and structure seem inseparable (being envisaged holistically as a totally integrated organism). With multilevel architectonic self-similarity, music is thus transmuted into a veritable universe of sound, whose macrocosm, mesocosms, and microcosm may be moulded identically – into proportionate unity.

Such a compositional achievement is (not surprisingly) ever so natural. The basic archetypical form of a tree, for example, is a hierarchy that stems from a single bifurcatory structural principle – a shaft with forking offshoots – which is replicated across many scales of arborescence: the tree-trunk supports its boughs; a bough subdivides into minor branches; these minor branches ramify into sub-branches; ... down to a twig and its twiglet offshoots (at the ends of which are the tree’s leaves). More generally, contemporary scientists have adopted a ‘new’ paradigm, realizing that physicality itself is better understood as waveform, as pattern, as vibration – as ratio. Indeed, our stratified Universe is innately *musical* throughout every one of its spatial orders, being underpinned by fluctuation and proportionality; it is apparently not – as Sir Isaac Newton put it when theorizing about the transmission of light – corpuscular. Furthermore, those elemental geometric forms which propagate structure and ratio subsist invisibly, in abstract, *a priori* within the supranatural ‘World of Being’; yet they are embodied in our sensory ‘World of Becoming’ within music – or as reified ‘material’:

In science today we are witnessing a general shift away from the assumption that the fundamental nature of matter can be considered from the point of view of substance (particles, quanta) to the concept that the fundamental nature of the material world is knowable only through its underlying patterns of wave forms. Both our organs of perception and the phenomenal world we perceive seem to be best understood as

systems of pure pattern, or as geometric structures of form and proportion. Therefore, when many ancient cultures chose to examine reality through the metaphors of geometry and music ... they were already very close to the position of our most contemporary science. Professor Amstutz of the Mineralogical Institute at the University of Heidelberg recently said:

Matter's latticed waves are spaced at intervals corresponding to the frets on a ... guitar with analogous sequences of overtones arising from each fundamental. The science of musical harmony is in these terms practically identical with the science of symmetry in crystals.

The point of view of modern force-field theory and wave mechanics corresponds to the ancient geometric-harmonic vision of universal order as being an interwoven configuration of wave patterns. Bertrand Russell, who began to see the profound value of the musical and geometric base to what we now call Pythagorean mathematics and number theory, also supported this view in **The Analysis of Matter**: 'What we perceive as various qualities of matter', he said, 'are actually differences in periodicity'. ... These proportions [residing in those elemental forms behind physical objects] can be understood to exist *a priori*, without any material counterpart, as abstract, geometric relationships. The architecture of bodily existence is determined by an invisible, immaterial world of pure form and geometry. ... Within the human consciousness is the unique ability to perceive the transparency between absolute, permanent relationships, contained in the insubstantial forms of a geometric order, and the transitory, changing forms of our actual world. The content of our experience results from an immaterial, abstract, geometric architecture which is composed of harmonic waves of energy, nodes of relationality, melodic forms springing forth from the eternal realm of geometric proportion.¹⁴

Multilevel architectonic self-similarity permeates our Universe, from the shell of a *Nautilus pompilius* to the gigantic curves of a 'spiral nebula', from the infinitesimal world of atomic structures through to the spectacular morphology of galaxies and stellar clusters; yet all of it is infused with *oscillation*. "Self-similarity, or invariance against changes in scale or size", says Manfred R. Schroeder, "is an attribute of many laws of nature and innumerable phenomena in the world around us. Self-similarity is, in fact, one of the decisive symmetries that shape our universe and our efforts to comprehend it".¹⁵ Let us now briefly survey this vision of a musical 'pattern that connects'.

In 1924, the French physicist Louis-Victor de Broglie propounded his theory of 'wave-particle duality'. Put succinctly, it states that anything within the Cosmos (including seemingly solid matter) can be regarded as consisting either of particles or of waveforms – depending upon how one observes it.¹⁶ Slightly later, Erwin Schrödinger (thence Werner Heisenberg and Paul Dirac, among others) formalized Quantum Mechanics, wherein the motion of an electron about its atomic nucleus is characterized in terms of standing waves – somewhat like those of a vibrating membrane which emits sound.¹⁷ Niels Bohr's theory of atomic energy levels (or 'quantum shells') accords perfectly well with the above 'wave mechanics' model.¹⁸ It is indeed a close microcosmic analogue of the Pythagorean-Platonic cosmography postulated over two millennia previously: the 'Music of the Spheres',

in which our Universe is visualized as a hierarchy of vibrating strata.¹⁹ In particular, compare Bohr's atomic blueprint – i.e. shells of electrons, in discrete quantal strata, oscillating about a central core – with the heliocentric organization of our own solar system, whose many moons circle planets that themselves orbit with various periodicities (and so 'vibrate') around the Sun, just as the sixteenth-century Polish astronomer Copernicus affirmed. Thus we do perceive 'macrocosm' and 'microcosm' – all-vibrational – exhibiting equivalent behaviours; the paradigm is identical. But what of space itself? The American physicists Arno Penzias and Robert Woodrow Wilson in 1965 discovered, and were the first scientists to measure, the uniform electromagnetic background radiation – yet another cosmic vibrational phenomenon – that diffuses throughout space;²⁰ most astrophysicists believe this microwave blanket to be an energy halo-remnant (or afterglow) of the Big Bang which is thought to have initiated our Universe.²¹ Truly, the Creation is a musical masterpiece whose multilevel architectonic self-similarity is everywhere evident – as merely one vestige of a Divine, perpetual composerly intelligence.

For certain humanly-composed music, too, the seeds of its macroform are contained within its microcosms. Nature often inspires such unificatory ideas in ruminative artists; but so too does the perennial philosophy – Hermeticism – which declares that Man (i.e. *Homo sapiens*) is such a microcosm relative to the macrocosm that comprises our Universe:

[The Macrocosm is the] universe with its stars, planets and signs of the zodiac; the world in its entirety. Its opposite is the Microcosm, which is the world in its particulars, particularly man. ... Since Boethius, the microcosm has been a term for man as a "mirror of the world". According to Hildegard von Bingen, Giordano Bruno, Leibniz, and many others (particularly during the Renaissance, such as Agrippa von Nettesheim), the microcosm is also a term for the human soul. ... The parallel between Microcosm and Macrocosm [is] probably very old, having existed in the ancient Near East: "that, which is below, is equal to that, which is above, ...". ... Microcosm-macrocosm thinking probably originated in ancient myths, according to which "everything" was supposedly formed out of a single pre-temporal being. The alleged parallel is one of the most important basic ideas in astrology and in many areas of alchemy, having persisted from antiquity ("Tabula smaragdina" [The Emerald Tablet]), through the mystical-symbolic thinking of the Middle Ages (as with Hildegard von Bingen and Agrippa von Nettesheim), into modernity (as with Boehme, Goethe and Novalis), and up to present forms of esoterica. Microcosm-macrocosm thinking had a decisive influence on symbolism in antiquity and in the Middle Ages.

The church father Gregory the Great (540–604) said, "Homo quodam modo omnia", "in a certain way, man is everything". Man, the microcosm, is also a macrocosm, a complete, yet small universe carrying within himself the inanimate order of minerals, the animate order of plants and animals, and the mental, the spiritual order that is common to men, the angels and God. Petrus Damiani (1007–1072), a church father, states even more emphatically: Man is named "microcosm", or "world in miniature", after a Greek word because he is composed in his material being of the same four [alchemic] elements as the universe. Up into modernity, man, the microcosm, always stands in the foreground; only the surroundings or the zodiac in its variously depicted forms constitute the macrocosm, as was the case even with Robert Fludd²² (1574–

Concepts such as macrocosmic-microcosmic *analogia*, or the Universe being Man writ large, are by no means restricted just to the ambit of the Western philosophical tradition. Hermetic thought – which recognizes that the human form itself incorporates key numerical data – is not only venerable, it is also pancultural. Anthropometrically proportioned temples and other sacred edifices (including musical compositions) are, in this light, ‘mesocosmic’. So, the whole spectrum of physical existence is bound together, inextricably, by underlying *proportion*. One might even maintain that such multilevel architectonic self-similarity is alchemical – a kind of all-embracing Philosophers’ Stone:

The geometric cosmology we have been surveying is part of a mystic doctrine of creation known as anthropocosmic, a doctrine which is fundamental to the esoteric tradition in philosophy since the earliest times, and which has been restated in our own time by Rudolf Steiner, R. A. Schwaller de Lubicz and others. ... We may use the analogy of the seed and the tree: the tree of the universe is the actualization of the seed potential which is Cosmic Man. I am using the word Man here in relation to its Sanskrit root *manas*, meaning ‘mind’, or the consciousness which can reflect upon itself. ... Through [this] vision of Man as Cosmos, the Anthropocosm, sacred geometry becomes a cosmogram depicting the drama of this divine birth. And during all temple-building epochs the sacred architecture based on this geometry has been a book revealing this eternal drama.

In India the *Vastupurushamandala*, the tradition of temple design founded on Cosmic Man, is still alive. We also find that the architectural model for the great Gothic cathedrals was the universal Christ-Man on the cross of creation.²⁴ In Egypt there is one great temple patterned on the human figure. This is the Temple of Luxor, where Cosmic Man is figured, in both the architecture and in the ritual bas-relief designs, as in the process of being born. The Hindu architectural sutra says, ‘The Universe is present in the Temple by means of proportion’. ...

The human body contains in its proportions all of the important geometric and geodesic measures and functions. The ancient Egyptian cubit, which is a time-space commensurate measure (1/1000th of the distance that the earth rotates at the equator in one second of time), the foot, the fathom, the ancient Egyptian equivalent to the metre, all these measures are commensurate with the size or movements of the earth. The relationship of Φ [the Golden Section ratio] is given by the navel. In the ideal proportions of Man the arm-span in relation to the total height gives the chord-arc relation for an arc of 60° . The height of the upper body (above the hip-socket) is in relationship to the total height as the volume of a sphere is to the volume of its circumscribing cube ($[1:6/\pi \approx] 1:1.9098[6]$). Also the height of the upper body is to the height of the pubic arch as $\pi/3:1$ or $1.047:1$. Thus the proportions of ideal man are at the centre of a circle of invariant cosmic relationships. Through an identification with the essential universal proportions expressed through this ideal human form, individual man may contemplate the link between his own physiology and universal cosmology, thereby envisaging a relationship with his own universal nature. This array of universal proportions within the body of Ideal Man becomes the basis, in many civilizations, of a canon which governs the metre for chant and poetry, the movements of dance, and the proportions of crafts, [music,] art and architecture. ...²⁵

The idea of Cosmic Man is [also] echoed in contemporary science in the concept of the hologram, which demonstrates that each fragment of a whole contains the

constituents of the overall structure of the whole. At the same time, as a particular partial of that whole, it expresses itself as an individual. In ancient science the metaphoric application of the notion of the Anthropocosm was the basis for astrological philosophy, and in alchemy it may be found again as the search for the Philosophers' Stone – 'that part in which the whole may be found'. ...²⁶

And again, this "Philosophers' Stone" is acknowledged by some people to be the Crucified Christ who is Logos – the creative and sustaining substrate of our Universe: Jesus' flayed body nailed to the Cross has been symbolized by certain Renaissance hermetics as a fretted string instrument, the fleshy strands of which are stretched across a wooden resonator and then stopped, like the filament of a monochord, according to predetermined ratios that generate well-proportioned, harmonious musical intervals:

... Greek philosophers used the word for wood, *hyle*, to denote the material substratum of the universe, passive to all the formative forces which may well be looked upon as vibratory or musical in nature. The ultimate symbol of this is the figure of Christ, the Creative Logos, crucified upon the wooden Cross, its four beams representing among other things the four [alchemical] elements [of 'earth', 'water', 'fire', and 'air'] that make up the material world. The metaphysical poet George Herbert (1593–1633), contemplating this, wrote in his poem **Easter**:

The crosse taught all wood to resound his name,
Who bore the same.
His stretched sinews taught all strings, what key
Is best to celebrate this most high day.

Since Herbert was still part of the late Renaissance intellectual movement which accepted the doctrine of correspondences, the parallel between the Crucified and a stringed instrument is no mere poetic conceit but the representation of a true harmony or resonance between different levels of the cosmos. The doctrine of correspondences, which has its first foundation in the Hermetic axiom 'As above, so below', regards these likenesses not as chance or whim but as the very texture of a cosmos which without them would lapse (as it has for some people today) into meaninglessness.²⁷

This Hermetic "doctrine of correspondences" – or, multilevel architectonic self-similarity – between different orders of magnitude in our Universe, suffuses it, proportionally and vibrationally, and therefore floods any composition which resonates such a unific template with *cosmic and theological meaning*.^{44b}

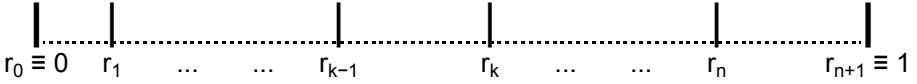
But *avant-propos* to the weighty topic of semiotics, how, from its inception, does a composer engineer proportional self-similarity in a piece of music?

The Arithmetic of Proportional Self-Similarity

I shall supply the mathematical formulae for only three adjoining tiers of proportional self-similarity (i.e. macro-, meso- and microlevels relative to one another, from somewhere within a composition's complete temporal spectrum); for it is, in practice, rather unusual –

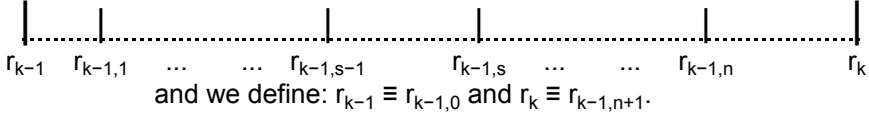
though by no means impossible – to extend this unifying process beyond three contiguous structural planes of musical chromomorphology.

As before, we begin by ‘normalizing’ a time-segment, and then fractionate it with n divisors $r_1, r_2, r_3, \dots, r_k, \dots, r_n$ (with $0 < r_1 < r_2 < r_3 < \dots < r_k < \dots < r_n < 1$). To circumvent computational troubles later on, we also establish the protocol that $r_0 \equiv 0$ and $r_{n+1} \equiv 1$:

1. **macrolevel:** 

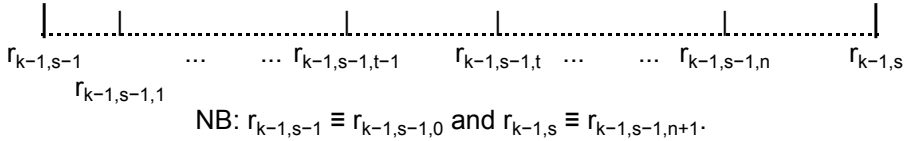
We now repeat this divisional procedure between the continuous subinterval r_{k-1} to r_k for each k , $1 \leq k \leq n+1$, in order to produce the $(n \times n+1)$ mesopartitions

$$r_{k-1,s} = r_{k-1} + (r_k - r_{k-1}) \times r_s, \text{ for } 1 \leq s \leq n:$$

2. **mesolevel:** 

To map out the microlevel, we now focus upon every one of those unbroken segments $r_{k-1,s-1}$ to $r_{k-1,s}$, where $1 \leq k \leq n+1$ and $1 \leq s \leq n+1$. Their $(n \times n+1 \times n+1)$ microproportions are

$$\begin{aligned} r_{k-1,s-1,t} &= r_{k-1,s-1} + (r_k - r_{k-1}) \times (r_s - r_{s-1}) \times r_t \\ &= r_{k-1} + (r_k - r_{k-1}) \times (r_{s-1} + (r_s - r_{s-1}) \times r_t), \text{ with } 1 \leq t \leq n: \end{aligned}$$

3. **microlevel:** 

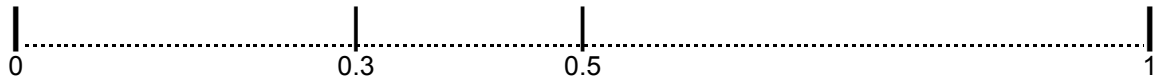
Note that within each architectonic level here, the set of $n+1$ emergent *ratios* remains invariant, just as one would expect from proportional self-similarity –

$$r_1 : (r_2 - r_1) : (r_3 - r_2) : \dots : (r_k - r_{k-1}) : \dots : (r_n - r_{n-1}) : (1 - r_n).$$

Furthermore, we can infer that proportional self-similarity is indeed present simply by inspecting the arithmetic, since the mesolevel and the microlevel equations both parade the general multiplicative formula $(r_{a-1} + (r_a - r_{a-1}) \times r_b)$.

As a concrete example of proportional self-similarity, let $r_1 = 0.3$ and $r_2 = 0.5$ (i.e. $n = 2$);

the macrolevel therefore looks like –



– and so the proportional quantities at the mesolevel are:

$r_{0,1} = 0.09$ and $r_{0,2} = 0.15$ (between $r_0 \equiv 0$ and $r_1 = 0.3$);

$r_{1,1} = 0.36$ and $r_{1,2} = 0.4$ (between $r_1 = 0.3$ and $r_2 = 0.5$);

$r_{2,1} = 0.65$ and $r_{2,2} = 0.75$ (between $r_2 = 0.5$ and $r_3 \equiv 1$).

Hence we are now able to behold *two* proportionately isomorphic layers of structure:



The microstructural data can then be tabulated:

$r_{0,0,1} = 0.027$ and $r_{0,0,2} = 0.045$ (between $r_0 \equiv 0$ and $r_{0,1} = 0.09$);

$r_{0,1,1} = 0.108$ and $r_{0,1,2} = 0.12$ (between $r_{0,1} = 0.09$ and $r_{0,2} = 0.15$);

$r_{0,2,1} = 0.195$ and $r_{0,2,2} = 0.225$ (between $r_{0,2} = 0.15$ and $r_1 = 0.3$);

$r_{1,0,1} = 0.318$ and $r_{1,0,2} = 0.33$ (between $r_1 = 0.3$ and $r_{1,1} = 0.36$);

$r_{1,1,1} = 0.372$ and $r_{1,1,2} = 0.38$ (between $r_{1,1} = 0.36$ and $r_{1,2} = 0.4$);

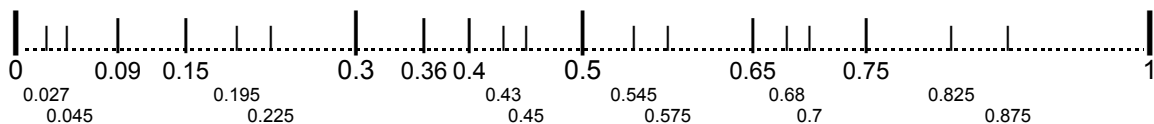
$r_{1,2,1} = 0.43$ and $r_{1,2,2} = 0.45$ (between $r_{1,2} = 0.4$ and $r_2 = 0.5$);

$r_{2,0,1} = 0.545$ and $r_{2,0,2} = 0.575$ (between $r_2 = 0.5$ and $r_{2,1} = 0.65$);

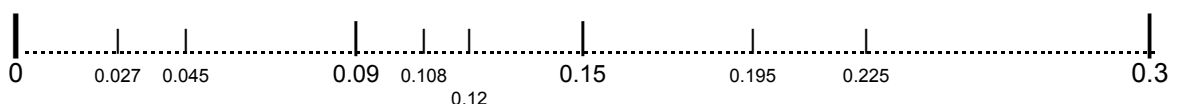
$r_{2,1,1} = 0.68$ and $r_{2,1,2} = 0.7$ (between $r_{2,1} = 0.65$ and $r_{2,2} = 0.75$);

$r_{2,2,1} = 0.825$ and $r_{2,2,2} = 0.875$ (between $r_{2,2} = 0.75$ and $r_3 \equiv 1$).

The three strata of self-similar proportional designs (i.e. macro-, meso- *and* microlevels), all of them delineated together below, make quite an involute yet thoroughly unified pattern, which sprouts from a ‘seed’ of just two numbers:



see below see below



The structure of this mysteriously well-proportioned design is akin to that of a ‘fractal’ – i.e. a fractional-dimensional object which exhibits self-similarity over infinitely many architectonic strata – although its self-similar proportionality is bounded at just three levels. (Scientists have recently come to appreciate that Fractal Geometry,²⁸ a close cognate of Chaos Theory, possesses much explanatory power to sharpen our understanding of natural phenomena and the behaviour of complex systems.)

Multilevel Architectonic Self-Similarity – Composerly Predecessors, Proportions and Beyond

The instances of proportional self-similarity scrutinized so far herein have all been *synchronous*, in that their proliferative ratios are nested, ‘simultaneously’, across adjacent architectonic planes. It is, however, feasible also to compose proportionally self-similar structures whose elements unfold ‘through time’, in succession; in this case we speak rather of *diachronous* self-similarity. One set of durations within my **153 Infinities** consists of two ‘arithmetic sequences’ that are diachronously self-similar;²⁹ and, as shall be demonstrated in section 1.2.11.2, whenever one creates a ‘geometric progression’ of time-spans, proportional self-similarity ineluctably asserts itself. Yet architectonic self-similarity need not implicate proportion: it may be more *abstract*, and spawn unity by operating instead with purely algebraic processes or functional formulae. For example, whenever one cyclic group of permutations straddles – and acts as a ‘force-field’ upon – different architectonic tiers, then the unifying principle of self-similarity is inevitably dignified: unity is attained through an holistic approach to the re-ordering of the same class (or perhaps many classes) of musical objects across various chromorphological strata, in that essentially a single permutation engenders *all* such transformational data; (abstract) self-similarity thus materializes because there now exists a processual homology between distinct structural planes. Likewise, the mathematics of equal temperament, when applied both to pitch-collections and to scales of tempi (through which tempo-glissandi glide), gives rise to another type of *abstract self-similarity*, between the time domain and the ‘tempo domain’ of a composition.³⁰

During the twentieth century, arguably the leading composerly practitioner of multilevel architectonic self-similarity has been Karlheinz Stockhausen, who – particularly within his magnificent creative output from the 1950s – strove to promulgate unity throughout the temporal continuum of his music by means of microcosm-to-macrocosm equiproportionality: “... The basic concept of the piece [**Klavierstück VIII**] is that of a hierarchic system of formal subdivisions into ever smaller units, all levels of the formal structure being regulated by the same sets of proportions. ...”³¹ More recently, much of

Chris Dench's music encrypts cherished individuals' names into it by way of a *gematria* which equates each distinct letter of a person's name with some quantity; these numerical values in turn regulate durational proportions across at least two architectonic layers of a piece. However, Dench's proportionality is not exactly self-similar, because he reshapes it from one level to another according to a homeomorphic network of 'sliders':

In **Dé/ployé**, [his] first piece to make comprehensive use of 'secret names', [Chris] Dench had already realised that the 'nesting' of the same discrete proportions into every level of the rhythmic structure was (a) impractical and (b) uninteresting. Accordingly, he devised sliding scales of values in which the original number sequence [governing proportions] was the most differentiated, and various degrees of 'gradient' served to 'flatten' or smooth out the level of difference between values. In a way, this is analogous to what [Karlheinz] Stockhausen did with the pitches in **Mantra**, where the basic 'formula' is subject to various systematically deployed 'expansions'. With Dench, however, this process operates in the opposite direction – reducing differences, rather than exaggerating them. ...³²

Although, as one might well imagine, I do not assent to the view that a rigid, precise proportional self-similarity is either "impractical" or "uninteresting" *per se*, the notion of 'morphing' proportional quantities $\{r_k\}$ between the microlevel and the macrolevel of some durational construct – i.e. gradually mutating the set $\{r_k\}$ into some new set, $\{R_k\}$, for all k , $1 \leq k \leq n$ – seems to me to be a worthwhile compositional technique that does not necessarily compromise formal unity. And somewhat like my friend Chris Dench, I too invoke Kabbalistic procedures in my piece **Lines of Light: Seven Improvisations on αιθερος μελος**, to control its multilevel architectonic self-similarities which are founded upon proportions *and* upon abstract algebraics:

Proportional Self-Similarity and Abstract, Permutational Self-Similarity in Lines of Light: Seven Improvisations on αιθερος μελος

The sundry paracompositional impetuses and sources of inspiration behind my **Lines of Light: Seven Improvisations on αιθερος μελος** – literature, rainbows and the physics of solar spectra, cosmology, *gematria* and mystical theology, the assassination of a friend's mother in Israel – as well as its proportionate structure and teleological strategies toward some state of cognitive 'order', are all disclosed within my own Programme Annotation to this piece:

My title "Lines of Light" is appropriated from a novel of the same name by Daniele Del Giudice, consisting almost entirely of a dialogue between a novelist and a theoretical physicist. I have been able, with this title, to genuinely imbue [my composition] with meaning at a number of levels. Metaphorically, **Lines of Light** invokes the notion of solar spectra, as manifested by the phenomenon of the arcing rainbow which appears to comprise seven colours and various Fraunhofer absorption lines (dark spectral bands – suppressed frequencies – evincing the coolness of the Sun's surface compared to its much hotter core). Hence, this piece embraces seven

sections, all but the last being proportioned according to the relative wavelengths of Fraunhofer lines A to H. ... Beyond this physical metaphor, I have extensively utilized more ancient and mystical associations with the word/ikon of light. The final section of **Lines of Light**, *αιθερος μελος* (*aitheros melos*: “Music of the Spheres”) – a transcription from an earlier version of this piece [which I have now withdrawn] – exhibits a temporal organization and proportions which are determined by *gematria*, the Ancient Greek (and Jewish) Kabbalistic system of isopsephial equivalence between word and number that demonstrates various geometrical truths, and ascribes arithmetically a network of hidden connections to otherwise distinct words and archetypes. (In addition to certain Gnostic texts, the ... Holy Scriptures [of] the New Testament ... are all supersaturated with the silent, mysterious truths of ‘number’.) On the other hand, the first six “improvisations” in **Lines of Light** – whose basis-materials nonetheless stem from the fully composed *αιθερος μελος* – were planned to fill out 485 seconds, proceeding from ‘chaos’ to ‘order’. (485 ≈ IEYOY, the Greek mystics’ *Tetragrammaton*, equivalent to the OM of Eastern cosmogony. Also, not insignificantly ... 485 ≈ ‘Ο Παναγιος: The All-Holy.) **Lines of Light** ... commissioned by the neoteric new-music ensemble *austraLYSIS* ... is dedicated to the memory of Barbara Burke – an Australian Christian worker murdered in Jerusalem during the early 1990s. Her name, together with various Biblical epigrams on ‘light’^{40b} (φως: *phos*), is cryptically encoded into the music. (I do trust that Mrs Burke would have approved of the esoteric Christian imagery!)³³

As I have openly avowed above, the chronomorphology of **Lines of Light: Seven Improvisations on αιθερος μελος** springs essentially from a marriage of two numerical concepts: the wavelengths of particularly prominent Fraunhofer absorption lines within solar spectra, and Greek *gematria*. “The dark *Fraunhofer lines* in the solar spectrum ... occur because the luminous sun, which radiates approximately like a blackbody at 5800°K, is surrounded by an envelope of cooler gas that absorbs light of certain characteristic wavelengths”,³⁴ for physicists, they also signal the presence within our Sun of at least sixty distinct elements from the periodic table.³⁵ The designations of these Fraunhofer lines, as well as their numerical, visual and chemical data, are as follows:³⁶

Name	Wavelengths *	Colours †	Elements ‡	With H → 0	Differences *
A	≈ 7594 Å	Red	O ₂ {Oxygen}	3626	A – C = 1031
C	≈ 6563 Å	Red-Orange	H {Hydrogen}	2595	C – D = 670
D	≈ 5893 Å	Yellow	Na {Sodium}	1925	D – E = 623
E	≈ 5270 Å	Green	Fe {Iron}	1302	E – F = 409
F	≈ 4861 Å	Blue	H {Hydrogen}	893	F – G = 553
G	≈ 4308 Å	Violet	Fe & Ca {Iron & Calcium}	340	G – H = 340
H	≈ 3968 Å	Ultraviolet	Ca {Calcium}	0	—

* The Fraunhofer lines’ wavelengths are measured in Angstrom units (Å): 1 Å = 10⁻¹⁰ metres. NB: because the data in the ‘differences’ column will eventually be reduced to proportions (thence to relative durations), the actual unit of measurement used here becomes irrelevant. Astonishingly, those three aeonial constants $\sqrt{2}$, $\sqrt{3}$, and $\Phi = ((\sqrt{5} - 1) \div 2)$ are also latent herein, linking (albeit approximately) the wavelength of Fraunhofer line E to that of Fraunhofer line G – i.e. $5270 \text{ Å} \times \sqrt{2} \div \sqrt{3} \approx 4302.94 \text{ Å} \approx 4308 \text{ Å}$ – as well as mediating the two wavelength-intervals between Fraunhofer lines F, G and H – i.e. $553 \text{ Å} \times \Phi \approx 341.77 \text{ Å} \approx 340 \text{ Å}$.

† The Fraunhofer lines lie within these colours of the rainbow.

‡ Each Fraunhofer line correlates with a spectral line (or narrow band) belonging to the indicated element. The atomic-spectral homologues in this column have been corroborated also by a reliable Internet website, Harmsworth (2001).

Fraunhofer lines A to G all lie within a light frequency-range that is visible to human eyes (as with the manifest colours of a rainbow), and yet – although such an absorption phenomenon is characterized by blackness – they do merit the caption ‘lines of light’: indeed, their wavelengths correspond very precisely to those of certain radiant lines within the solar emission spectrum.³⁷ But just how are these ‘lines of light’ metamorphosed into formal proportions within my **Lines of Light: Seven Improvisations on αιθερος μελος**? Now we see from the tabulation above that the full gamut of Fraunhofer lines from A to H traverses 3626 Å; this number is also equal to the total of those ‘differences’ in its rightmost column, which therefore partition 3626 into six segments. So, my intention was to scale all of these numbers accordingly, in order that line A would correspond to 485 seconds, line C to $(2595 \times 485 \div 3626)$ seconds, and so on – furnishing six time-spans (total: 485 seconds) whose relative proportions would match exactly those of the Fraunhofer-line wavelength-intervals 340:553:409:623:670:1031.

But what is the great significance of the number 485? To answer this question, it proves necessary for us to make a small detour into the rather rarefied clime of Ancient Greek *gematria* – that Kabbalistic system of reciprocity between each letter of the Greek alphabet and some whole-number quantity,³⁸ as set forth in any lexicon of Ancient Greek:

Letter	Quantity	Letter	Quantity	Letter	Quantity
A α	1	I ι	10	P ρ	100
B β	2	K κ	20	Σ σ, ς	200 * †
Γ γ	3	Λ λ	30	Τ τ	300 †
Δ δ	4	Μ μ	40	Υ υ	400
Ε ε	5	Ν ν	50	Φ φ	500
Ζ ζ	7	Ξ ξ	60	Χ χ	600
Η η	8	Ο ο	70	Ψ ψ	700
Θ θ	9	Π π	80	Ω ω	800

* The *digamma* or *stigma* symbol (ς), representing the number 6, fell out of use. Rather confusingly, the outwardly identical symbol ς is also a lower-case *sigma* that only ever appears as the final letter of a Greek word (in which case it possesses the value 200 by *gematria*).

† Whenever σ and τ occur together, as στ, the value by *gematria* is usually 6 – and not 500, as one might expect. (στ, a semi-compound letter known as ‘*stau*’ [σταν], is most commonly written at the beginning of Greek words.)

To evaluate a Greek word numerically, by *gematria*, one merely sums those quantities which correspond to each of its letters. We thereby discover that the number 485 carries much symbolic *gravitas*, because:

485 = IEOY (a kind of Greek *Tetragrammaton*, or ineffable name of God);

485 = ‘Ο Παναγιος (the All-Holy, another epithet of God);

485 = ΙΕΣΟΣ (a variant spelling of Jesus);

485 = ‘Ο αληθης Ἀνηρ (Man of Truth).

Also, $3395 = 7 \times 485 = \Phi\omega\varsigma \text{ εκ } \Phi\omega\tau\omicron\varsigma$ (“Light of Light”, from the Nicene Creed).³⁹

Hence, through invoking the number 485 – whereby the first six sections of **Lines of Light: Seven Improvisations on αιθερος μελος** last exactly 485 seconds, being proportioned in conformity with the relative wavelengths of Fraunhofer lines A to H – I invest this work with further meaning: via *gematria*, some names of God are exalted (within a ‘theology of light’); the piece’s proportionality symbolizes solar phenomena and the Sun itself, together with all of our Sun’s semiotic overtones.⁴⁰ Truly I have composed into this work a ‘music of sunlight’, whose sixfold demarcation into sections and overall duration together transmit significance.

For **Lines of Light: Seven Improvisations on αιθερος μελος**’s first six “improvisations”, the pertinent data are:

The total time-span $d = 485''$. Now, in order to calculate this composition’s first six sectional lengths (which are labelled S_1 to S_6 below), we let $L = d \div 3626 \approx 0.1337562052''$.

Section *	Fraunhofer Lines	Wavelengths (in Å)	Time-Spans (in seconds)	Derivation (from the wavelength differences)
6	A to C	$\approx 7594 \text{ Å to } \approx 6563 \text{ Å}$	$S_6 \approx 137.903''$	$L \times 1031 \text{ Å}$
5	C to D	$\approx 6563 \text{ Å to } \approx 5893 \text{ Å}$	$S_5 \approx 89.617''$	$L \times 670 \text{ Å}$
4	D to E	$\approx 5893 \text{ Å to } \approx 5270 \text{ Å}$	$S_4 \approx 83.330''$	$L \times 623 \text{ Å}$
3	E to F	$\approx 5270 \text{ Å to } \approx 4861 \text{ Å}$	$S_3 \approx 54.706''$	$L \times 409 \text{ Å}$
2	F to G	$\approx 4861 \text{ Å to } \approx 4308 \text{ Å}$	$S_2 \approx 73.967''$	$L \times 553 \text{ Å}$
1	G to H	$\approx 4308 \text{ Å to } \approx 3968 \text{ Å}$	$S_1 \approx 45.477''$	$L \times 340 \text{ Å}$
1 – 6	H to A	$\approx 3968 \text{ Å to } \approx 7594 \text{ Å}$	$d = 485.000''$	$L \times 3626 \text{ Å}$

* NB: these section-numbers are *purely conceptual*, and shall be subject to systematic permutation by a cyclic group.

And yet, like the seven ostensible colours of a rainbow, I have crowned **Lines of Light** with a seventh and final “improvisation”⁴¹ whose harmonic materials infuse the rest of the piece – to render a type of ‘variations-and-theme’ structure, as it were. My original sketches of this seventh section comprised two clear-cut subsections, spanning 21 ♪s and 74 ♪s respectively. Somewhat later, I decided to predicate their temporalities upon the *gematria* of Αιθερος Μελος (“Music of the Spheres”: 740)⁴² and of Μελος Φωτος (“Melody of Light”: 2215). To do so – i.e. to deliver a perfectly accurate formal ratio 740:2215 – a transient duration Δ had to be grafted on to the end of the first subsection, such that $(21 + \Delta):74 \equiv 740:2215$; the length of the whole “improvisation”, (Αιθερος Μελος):(Μελος Φωτος), was then fixed at ≈ 74.542 seconds.⁴³

How were these seven sections (encapsulating *all* of my **Lines of Light: Seven Improvisations on αιθερος μελος**) to be put into order, then? For artistic reasons, I decreed that both the seventh and the fifth sections should stay in their original places; the other sections were all to be permuted by μ , where $\mu = (1, 6) (3, 2, 4) (5) (7)$. (Notice that

$\mu^6 \equiv \mu^0 = [1, 2, 3, 4, 5, 6, 7]$.) The permutation $\mu^1 = [6, 4, 2, 3, 5, 1, 7]$ was eventually chosen from the cyclic group $\langle \mu \rangle$ to order the “improvisations” themselves, as the table below – adapted from **Lines of Light**’s sketch-materials – shows:

Section (actual)	Section (conceptual)	Duration (in seconds)	Instrumentation	Rainbow Colour-Band
Improv. 1	6	$S_6 \approx 137.903''$	Tutti	Red to Red-Orange
Improv. 2	4	$S_4 \approx 83.330''$	Prepared alto recorder solo (with ‘interjections’)	Yellow to Green
Improv. 3	2	$S_2 \approx 73.967''$	Tubular bells, Yamaha DX7s	Blue to Violet
Improv. 4	3	$S_3 \approx 54.706''$	Tutti (with soprano recorder)	Green to Blue
Improv. 5	5	$S_5 \approx 89.617''$	Solo for Yamaha DX7s	Red-Orange to Yellow
Improv. 6	1	$S_1 \approx 45.477''$	Tenor recorder, percussion	Violet to Ultraviolet
Improv. 7	7	$S_7 \approx 74.542''$	Tutti (tubular bells just once)	{‘additional’ section}

As we shall see, **Lines of Light: Seven Improvisations on αιθερος μελος** enjoys a two-tiered proportional self-similarity; its chronomorphology is, therefore, ‘holographic’. Those proportions and the permutation μ which I engaged in transecting the whole 485 seconds thence redeploying its resultant time-segments, were exercised again *within* each of the first six “improvisations”: these macrostructural proportions and the cyclic group $\langle \mu \rangle$ are thus diffused throughout **Lines of Light**’s mesoform.⁴⁴ All of these “improvisations” parade some permutation (from $\langle \mu \rangle$) of the global image: so they, too, are rooted in the same philosophies as the whole – only in microcosm. Recall that the first 485 seconds of **Lines of Light** is fractionated by the ratios 340:553:409:623:670:1031 into $S_1 + S_2 + \dots + S_5 + S_6$. Now every one of **Improvisations 1** through to **6** has been divided by these same ratios; but another ratio, which corresponds to the time-span of **Improvisation 7** (i.e. $S_7 \approx 74.542''$), was used in this subpartitioning process as well. How has this been accomplished?

We first define $D = d + S_7 = S_1 + S_2 + \dots + S_6 + S_7 \approx 559.542''$ (this being the *total duration* of **Lines of Light: Seven Improvisations on αιθερος μελος**). The length of the m th subdivision from S_k – where $1 \leq k \leq 6$ and $1 \leq m \leq 7$ – will therefore be:

$$S_{k,m} = S_m \times S_k \div D.$$

For example, the duration of the fourth proportionalized time-segment from within **Improvisation 6** is: $S_{6,4} = S_4 \times S_6 \div D \approx 83.330'' \times 137.903'' \div 559.542'' \approx 20.537''$.

The table below demonstrates all of the various durational possibilities; it shows the time-span for each potential subsection within every “improvisation” except for **Improvisation 7** (which, we must recollect, is simply bifurcated – cast into the ratio

740:2215 through the *gematria* of Αἰθερος Μελος : Μελος Φωτος – without being in any way holographic):

(Sub)Sections * Section 1	Section 2	Section 3	Section 4	Section 5	Section 6
Subsection 1 $S_{1,1} \approx 3.696''$	$S_{2,1} \approx 6.012''$	$S_{3,1} \approx 4.446''$	$S_{4,1} \approx 6.773''$	$S_{5,1} \approx 7.285''$ †	$S_{6,1} \approx 11.208''$
Subsection 2 $S_{1,2} \approx 6.012''$	$S_{2,2} \approx 9.778''$	$S_{3,2} \approx 7.232''$	$S_{4,2} \approx 11.016''$	$S_{5,2} \approx 11.847''$	$S_{6,2} \approx 18.230''$
Subsection 3 $S_{1,3} \approx 4.446''$	$S_{2,3} \approx 7.232''$	$S_{3,3} \approx 5.349''$	$S_{4,3} \approx 8.147''$	$S_{5,3} \approx 8.762''$	$S_{6,3} \approx 13.483''$
Subsection 4 $S_{1,4} \approx 6.773''$	$S_{2,4} \approx 11.016''$	$S_{3,4} \approx 8.147''$	$S_{4,4} \approx 12.410''$	$S_{5,4} \approx 13.346''$	$S_{6,4} \approx 20.537''$
Subsection 5 $S_{1,5} \approx 7.284''$	$S_{2,5} \approx 11.847''$	$S_{3,5} \approx 8.762''$	$S_{4,5} \approx 13.346''$	$S_{5,5} \approx 14.353''$	$S_{6,5} \approx 22.087''$
Subsection 6 $S_{1,6} \approx 11.208''$	$S_{2,6} \approx 18.230''$	$S_{3,6} \approx 13.483''$	$S_{4,6} \approx 20.537''$	$S_{5,6} \approx 22.087''$	$S_{6,6} \approx 33.987''$
Subsection 7 $S_{1,7} \approx 6.058''$	$S_{2,7} \approx 9.854''$	$S_{3,7} \approx 7.288''$	$S_{4,7} \approx 11.101''$	$S_{5,7} \approx 11.939''$	$S_{6,7} \approx 18.371''$
Totals † $S_1 \approx 45.477''$ $S_2 \approx 73.969''$ $S_3 \approx 54.707''$ $S_4 \approx 83.330''$ $S_5 \approx 89.618''$ $S_6 \approx 137.903''$					

* Observe the elegant multiplicative symmetry here, which is intrinsic to our equation for $S_{k,m}$: $S_{a,b} \equiv S_{b,a}$ for all a and b . (This property is due to the commutativity of the real numbers; they form a ‘field’ with respect to the operations $+$ and \times .)

Do bear in mind, too, that proportional self-similarity will *always* generate such symmetries within every architectonic stratum it affects (apart from a piece’s macrostructure): the parity of certain segments from the time domain, thanks to the symmetry of multiplication, definitely causes a proportionally self-similar composition’s maze of relationality to grow, and therefore further elevates its structural unity.

† The small discrepancies for S_2 , S_3 , S_5 , (and $S_{5,1}$) here, as compared with their data in previous tables, occur because my computations were always rounded-off at the third decimal place.

However, within the score itself (and the performers’ parts) of **Lines of Light: Seven Improvisations on αιθερος μελος**, I quantized all durational values into simple fractional quantities, expressed in seconds, so as to enhance the ease with which this piece might be read; any slight errors which thereby infiltrate between my ideal compositional scheme and its notational culmination do turn out to be quite negligible in performance. Anyway, by studying these subsectional spans, one can effortlessly determine which permutation from $\langle \mu \rangle$ was employed to order the time-segments within each “improvisation”.

In **Improvisation 1**, every player elicits different permutations; but, being elements of the cyclic group $\langle \mu \rangle$, they are all algebraically cognate, and naturally fill out the same duration – S_6 – with the $\{S_{6,m}\}$ ($1 \leq m \leq 7$) in various orders, giving rise to unity. Thereafter, just a single permutation is allotted per “improvisation” – with one or more of the instrumental parts having bar-lines or subsectional partitions which coincide.

To variegate the prepared alto recorder’s solo in **Improvisation 2**, the two Yamaha DX7 synthesizers and certain metallic percussion instruments coordinate their attacks in launching some vivid, temporally unspecified ‘interjections’.

The table that follows proffers all of the germane facts; subsectional numbers therein

have all been subscripted in bold-face type, to assist with the cataloguing of permutational elements from μ :

	Improv. 1	Improv. 2	Improv. 3	Improv. 4	Improv. 5	Improv. 6
μ^1 :	S_6	S_4	S_2	S_3	S_5	S_1
Recorder	$S_{6,6}$	$S_{4,1}$	<i>tacet</i>	$S_{3,1}$	<i>tacet</i>	$S_{1,6}$
	$S_{6,2}$	$S_{4,4}$		$S_{3,4}$		$S_{1,2}$
	$S_{6,3}$	$S_{4,2}$		$S_{3,2}$		$S_{1,3}$
	$S_{6,4}$	$S_{4,3}$		$S_{3,3}$		$S_{1,4}$
	$S_{6,5}$	$S_{4,5}$		$S_{3,5}$		$S_{1,5}$
	$S_{6,1}$	$S_{4,6}$		$S_{3,6}$		$S_{1,1}$
	$S_{6,7}$	$S_{4,7}$		$S_{3,7}$		$S_{1,7}$
	$= \mu^3$	$= \mu^4$		$= \mu^4$		$= \mu^3$
Yamaha DX7s	$S_{6,1}$	'interjections'	$S_{2,6}$	$S_{3,1}$	$S_{5,6}$	<i>tacet</i>
	$S_{6,4}$		$S_{2,3}$	$S_{3,4}$	$S_{5,4}$	
	$S_{6,2}$		$S_{2,4}$	$S_{3,2}$	$S_{5,2}$	
	$S_{6,3}$		$S_{2,2}$	$S_{3,3}$	$S_{5,3}$	
	$S_{6,5}$		$S_{2,5}$	$S_{3,5}$	$S_{5,5}$	
	$S_{6,6}$		$S_{2,1}$	$S_{3,6}$	$S_{5,1}$	
	$S_{6,7}$		$S_{2,7}$	$S_{3,7}$	$S_{5,7}$	
	$= \mu^4$		$= \mu^5$	$= \mu^4$	$= \mu^1$	
Percussion	$S_{6,6}$	'interjections'	$S_{2,6}$	$S_{3,1}$	<i>tacet</i>	$S_{1,6}$
	$S_{6,3}$		$S_{2,3}$	$S_{3,4}$		$S_{1,2}$
	$S_{6,4}$		$S_{2,4}$	$S_{3,2}$		$S_{1,3}$
	$S_{6,2}$		$S_{2,2}$	$S_{3,3}$		$S_{1,4}$
	$S_{6,5}$		$S_{2,5}$	$S_{3,5}$		$S_{1,5}$
	$S_{6,1}$		$S_{2,1}$	$S_{3,6}$		$S_{1,1}$
	$S_{6,7}$		$S_{2,7}$	$S_{3,7}$		$S_{1,7}$
	$= \mu^5$		$= \mu^5$	$= \mu^4$		$= \mu^3$

The mesostructural boundaries are, on the whole, reasonably audible (and do become increasingly so as **Lines of Light: Seven Improvisations on *αιθερος μελος*** progresses), being delineated by changes in textural density, coordinated events, and by *harmony*: all but a handful of subsections draw their note-materials from some fountain-head of pitches – a 'harmonic field' – which is distinct from that of its neighbour(s). But therein lies another tale...⁴⁵

1.2.5 SYMMETRY-BREAKING AND THE DISRUPTION OF PROCESS

*“Est modus in rebus, sunt certi denique fines,
Quos ultra citraque nequit consistere rectum.”*

*There is a measure in things, there are certain fixed limits,
beyond and short of which rightness breaks down.*

– Horace: **Satyres**, I, i, 106.

“There is no Excellent Beauty, that hath not some strangeness in the proportion.”

– Francis Bacon: **Essays**, 43, ‘Of Beauty’.

An object possesses *symmetry* whenever there exists some transformation that, if applied to the object, leaves it invariant. When searching for symmetries, the most common transformative operations used are *reflection*, *translation*, and *rotation*.¹ For example, the human body has near-perfect bilateral symmetry because, under reflection about a vertical axis, its left-hand side is essentially the image of its right. If a design exhibits repetition, as with the hexagonal cells in bees’ honeycombs, then large areas of the things repeated can often be shifted onto other regions without changing the fundamental pattern: one part of the design looks much the same as another. Many types of flowers and starfish can be turned through certain angles so that their arrangements of petals and arms appear unaltered. All of these objects are therefore symmetrical. Yet ‘symmetry’ does have a higher, even more abstract meaning as well: anything that displays *harmonious proportions, relationships, or processes* is also said to be ‘symmetric’. So *symmetry-breaking* and the *disruption of process*, whereby symmetry is constructed then subverted, are both facets of the same basic principle.

Together with symmetry itself, the disturbance of symmetry is a powerful and beautiful artistic tool – since it is ever so natural. (Indeed, all physical existence within our Universe is contingent upon some asymmetry.)² Absolute symmetry is, moreover, utterly predictable and tedious, being completely static, uniform and undifferentiated; in practice, it is broken by some physical cause that begets new phenomena (as with ripples on the surface of a previously still, glassy pond that were motivated by a stone being tossed into it) where some, but by no means all, of the symmetry is lost:

Something in the human mind is attracted to symmetry. Symmetry appeals to our visual sense, and thereby plays a role in our sense of beauty. However, perfect symmetry is repetitive and predictable, and our minds also like surprises, so we often consider imperfect symmetry to be more beautiful than exact mathematical symmetry. Nature, too, seems to be attracted to symmetry, for many of the most striking patterns in the natural world are symmetric. And nature also seems to be

dissatisfied with too much symmetry, for nearly all the symmetric patterns in nature are less symmetric than the cause that gave rise to them. ... the world is full of effects that are *not* as symmetric as their causes, and the reason for this is a phenomenon known as “spontaneous symmetry breaking”.³

By what mechanism, though, are ‘causes’ – such as the laws of physics – more symmetrical than their ‘effects’ within the natural world? The astronomer and physicist John D. Barrow resolves this paradox, which springs from the age-old clash between Platonic and Aristotelian world-views:

The traditional laws of Nature dictating change can always be recast as equivalent statements that some ‘conserved’ quantities remain unchanged in all physical processes. Thus the conservation of linear momentum is equivalent to the fact that the laws of Nature must be the same in all places, the conservation of energy to the requirement that they be the same at all times, the conservation of angular momentum to their sameness in all directions of space. This Platonic approach has reached its zenith during the last fifteen years in the study of elementary particle physics. For whilst one can replace laws of Nature governing changes in space and time by statements that certain properties remain unchanging, these statements of solidarity can in turn be replaced by the dicta that certain patterns or ‘symmetries’ be preserved in Nature. ...

All the known forces of Nature – gravity, the strong nuclear force, the weak force, and electromagnetism – are described by varieties of gauge theory founded upon the immutability of some pattern when any change occurs. They are founded therefore upon the Platonic assumption that symmetry is fundamental and the ultimate expression of that faith is the search for a ‘Theory of Everything’ within which all these separate theories of the four different forces of Nature can be subsumed and unified into a single description of the ultimate symmetry, or law of Nature, from which all else follows. Whether that ultimate theory is a conventional gauge theory or a superstring theory, in which the most fundamental entities are lines or loops of energy rather than points, makes no difference to the appeal to symmetry. The primary appeal of superstring theories is that the further requirement that all calculable quantities be finite is sufficient to pin down just one or two possible all-encompassing symmetries within which those respected by the individual gauge theories of the forces of Nature can be embedded as pieces in the complete kaleidoscopic pattern of things. This success in beating a path towards one all-embracing symmetry – the Theory of Everything – through the complex jungle of experience lies behind claims of physicists that the Universe is simple and deeply symmetrical.

But there is a second tradition in the study of Nature that, until recently, has been less popular than the Platonic search for the invariants of Nature. The Aristotelian perspective laid emphasis upon the observable happenings in the world rather than the unobservable invariants behind it. As a result the process of temporal change was regarded as fundamental. It is no accident that the original advocates of such an emphasis drew their intuition more from the study of living things than the purposeless pendula of the physicist. For the advocates of this approach the world looks complicated and messy ... To understand the real difference between the simple Platonic view of the world and the complicated Aristotelian perspective we need to appreciate one important fact about the world: symmetrical laws of Nature need not have outcomes which possess the same symmetries as those laws. If we place a pencil in a vertical state and allow it to fall then it will fall in *some* direction. The laws governing the fall of the pencil do not have any special preference for one

direction over any other, but the pencil must fall in some particular direction and, in so doing, the underlying symmetry of the governing law of Nature is broken in the observed outcome of the law. Were this not so, then every outcome of the law of Nature would have to carry the full invariance of the laws. We could not be sitting in the spot we happen to occupy at the moment unless the laws of Nature showed a special favouritism for that spot. Thus we see that outcomes are much more complicated things than the laws of Nature. Moreover, we do not observe the laws of Nature: we observe only the outcomes of those laws and from the heap of broken symmetries before us we must work backwards to reconstruct the pristine laws behind the appearances. Sometimes this is very easy to do, but often it is impracticable because of the sensitivity of the direction of the symmetry-breaking to the whims of the environment. But we have learnt one important lesson. This process of symmetry-breaking explains how we can reconcile the existence of observed complexity [e.g. broken symmetry] with underlying laws of Nature that are simple [and symmetrical]. ...

... the world can be both simple and complicated in important ways and the aspect that impresses you most will depend upon whether you are more concerned with the laws of Nature or their outcomes.⁴

Many of the patterns that human beings observe and admire throughout the Cosmos – from those we detect at the quantum level, inhabited by infinitesimal subatomic particles, through to those found within the massive formations of galactic clusters – are underpinned by symmetry-breaking. So any humanly composed rupture of symmetry thereby gains its meaning and justification, as a metaphor of Creativity: when symmetry-breaking (being an activator of pattern in nature – not to mention its impetus behind physicality itself) is at play within music, it indeed allows ‘art’ to imitate ‘life’:

Volcanoes are conical, stars are spherical, galaxies are spiral or elliptical. ... [We must acquire] an understanding of these prevalent patterns ... why they are so common, and why many different aspects of nature show the *same* patterns. Raindrops and stars are spheres, whirlpools and galaxies are spirals, honeycombs and the Giant’s Causeway are arrays of hexagons. There has to be a general principle underlying such patterns; ... Symmetry breaking is just such a principle. But in order for symmetry to break, it has to be present to start with. ...⁵

Symmetric causes often produce *less* symmetric effects. The evolving universe can break the initial symmetries of the big bang. ... spherical blastula can develop into [a] bilateral frog. The 252 perfectly interchangeable units of adenovirus can arrange themselves into an icosahedron – an arrangement in which some units will occupy special places, such as corners. A set of twenty-seven perfectly ordinary microtubules can get together to create a centriole. ... but why patterns? Why not a structureless mess, in which *all* symmetries are broken? One of the strongest threads that runs through every study ever made of symmetry breaking is that the mathematics does not work this way. Symmetries break reluctantly. There is so much symmetry in our ... universe that there is seldom a good reason to break all of it. So rather a lot survives. Even those symmetries that do get broken are still present, in a sense, but now as potential rather than actual form. For example, when the 252 units of the adenovirus began to link up, any one of them could have ended up in a particular corner. In that sense, they are interchangeable. But only one of them ... *does* end up there, and in that sense the symmetry is broken: they are no longer interchangeable. But some of the symmetry remains, and [so] we see an

icosahedron.

In this view, the symmetries we observe in nature are broken traces of the grand, universal symmetries of our ... universe. *Potentially* the universe could exist in any of a huge symmetric system of possible states, but actually it must select one of them. In so doing, it must trade some of its actual symmetry for unobservable, potential symmetry. But some of the actual symmetry may remain, and when it does we observe a pattern. Most of nature's symmetric patterns arise out of some version of this general mechanism.⁶

... if we permit tiny asymmetric disturbances, which can trigger an instability of the full symmetric state, then our mathematical system is no longer perfectly symmetric. But the important point is that the tiniest departure from symmetry in the cause can lead to a total loss of symmetry in the resulting effect – and there are *always* tiny departures. ... It is much more informative to model a real system after one with perfect symmetry, but to remember that such a model has many possible states, only one of which will be realized in practice. Small disturbances cause the real system to select states from the range available to the idealized perfect system. Today this approach to the behaviour of symmetric systems provides one of the main sources of understanding of the general principles of pattern formation. In particular, the mathematics of symmetry breaking unifies what at first sight appear to be very disparate phenomena.⁷

Both John D. Barrow and Ian Stewart have affirmed within the passages quoted above that, in nature, symmetry must always be present in the first place in order for it to be subsequently fractured. Therefore, with any symmetry-breaking process, there will inevitably be two components (one potential – the underlying symmetry – and the other actual – a subversive asymmetry) which pursue seemingly opposite purposes. Moreover, although one by now might have gained the impression that symmetry-breaking is an entirely spatial phenomenon, this is not at all true: there are countless examples of symmetries which break in relation to the time domain (were this not so, symmetry and the disturbance of symmetry could never occur within music). For instance, the reed oscillations, and so the sound, of a clarinet being blown hard depend upon a mathematical condition known as Hopf bifurcation:

The important thing is that the musician does not have to blow in an oscillatory way (that is, in a rapid series of short puffs) to make the reed oscillate. This is typical of Hopf bifurcation ... [which] can be seen as a special type of symmetry breaking. ... the symmetries that break relate not to space but to time. Time is a single variable, so mathematically it corresponds to a line – the time axis. There are only two types of line symmetry: translations and reflections. What does it mean for a system to be symmetric under time translation? It means that if you observe the motion of the system and then wait for some fixed interval and observe the motion of the system again, you will see exactly the same behaviour. That is a description of periodic oscillations: if you wait for an interval equal to the period, you see exactly the same thing. So periodic oscillations have time-translation symmetry.⁸

However, the symmetry which is broken here is that of '*all* time-translations'. Any physical system which remains invariant under this symmetry must, *ipso facto*, exhibit

precisely the same behaviour at *all* moments of time, not just at intervals corresponding to the period of oscillation – and so the system would stay, by definition, in a steady state. But whenever the translational symmetry of periodically oscillating systems is to be preserved, they are only time-translatable by that period, and no other: thus, time-translational symmetries diminish from ‘all translations’ to only those over some entrenched time-span. In this respect, Hopf bifurcation is truly an example of temporal symmetry-breaking.⁹

In music, symmetry-breaking fulfils a productive rôle: it thwarts predictability, and thereby ushers in an extra compositional dimension (beyond that of the ‘potential’ symmetry it undermines). As with the Cosmos itself, symmetries and their disruptions are able to occupy any architectonic stratum of a compositional structure.¹⁰ Furthermore, it is an interesting concurrence that the symbolisms of, and cultural attitudes towards, symmetry and asymmetry – now long-established in the West – mirror the relatively recent discovery by scientists that causal laws (existing in abstract reality) exhibit more symmetry than their physical effects. In the spheres of art and architecture, symmetry signifies timeless eternity and the Divine (in a ‘World of Being’), whereas asymmetry rightly belongs to the created, mundane ‘World of Becoming’:

“Symmetry”, says Dagobert Frey in an article **On the Problem of Symmetry in Art**, “signifies rest and binding, asymmetry motion and loosening, the one order and law, the other arbitrariness and accident, the one formal rigidity and constraint, the other life, play and freedom”. Wherever God or Christ are represented as symbols for everlasting truth or justice they are given in the symmetric frontal view, not in profile. Probably for similar reasons public buildings and houses of worship, whether they are Greek temples or Christian basilicas and cathedrals, are bilaterally symmetric. It is, however, true that not infrequently the two towers of Gothic cathedrals are different, as for instance in Chartres. But in practically every case this seems to be due to the history of the cathedral, namely to the fact that the towers were built in different periods. It is understandable that a later time was no longer satisfied with the design of an earlier period; hence one may speak here of historic asymmetry.¹¹

For in contrast to the orient, occidental art, like life itself, is inclined to mitigate, to loosen, to modify, even to break strict symmetry. But seldom is asymmetry merely the absence of symmetry. Even in asymmetric designs one feels symmetry as the norm from which one deviates under the influence of forces of non-formal character.¹²

By embracing its potential antithesis, symmetry-breaking as a compositional technique both nurtures unity and serves, iconographically, to bridge the realms of Being and Becoming. Let us now peruse some examples within **A World of Becoming** of symmetry-breaking under its ‘higher’ guise of ‘the disruption of process’ – the subverted process in each case being ‘cyclical repetitions’.

Examples of Disrupted Processes from Arcturus Timespace, Cycles of Vega, and Solar Dust: Orbits and Spirals

Throughout sections F and G of **Arcturus Timespace**, the soloist incessantly cycles through a two-bar phrase of gentle percussion sonorities mixed together with occasional open-string tones from the mandolin. After its fifth repeat, during which the pre-recorded electroacoustic part continues to fade out, a clattering of windchimes cuts across the cyclic process just once (replacing the mandolin's plucked open A-string within the recurring phrase). The fact that within **Arcturus Timespace** this is the only event during which the windchimes are heard surely heightens their interruptive effect; the windchimes' chaotically ordered sonorities also function as a 'timbral echo' of the receding electroacoustic sounds. Furthermore, after this pre-recorded part has decayed completely into silence by section G, the repeated phrase itself fragments and dissipates after being played unaccompanied just once – thereby framing this work's terminal breakdown of process.

Bar 208 from **Cycles of Vega**, described in the score as “An (uncoordinated) interruption in the process, like a brilliant, blinding, coruscative wave of light!”, has a similarly disruptive effect upon processes in motion. This intercut of foreign material into an unfolding cyclical tapestry is meant to come as a total surprise to listeners, giving them an impression of ‘time standing still’, yet thwarting their obvious expectation that the encircling ‘clockwork mechanism’ will just wind down inexorably, unimpeded. (Bar 208 – being devoid of beat and tempo – also temporarily arrests a mathematically contoured tempo-glissando which overlays this cyclic process.)

In **Solar Dust: Orbits and Spirals** (p.3), a convolute passage that is repeated over and over again evolves according to instructions which are given verbally:

... Very gradually and smoothly increase the tempo and tension [to] AS FAST AND AS TENSE AS POSSIBLE! Push yourself and your instrument to the limit! At such high tempi, some rhythmic distortion together with performance errors such as wrong notes, incorrect techniques as well as various string and plectrum noises will surely occur. Do not worry unduly about this, and ABSOLUTELY do not lower the tempo: such ‘mistakes’ in moderation greatly enhance the piece! ...¹³

These unavoidable yet unforeseeable performative “mistakes” are, I believe, a musical enrichment precisely because they are symmetry-breaking. And as with the final section of **Arcturus Timespace**, we have a repeated phrase near the conclusion of **Solar Dust: Orbits and Spirals** whose degeneration is also an explicitly composed disruption of process.

Symmetry-Breaking within Dimensiones Paradisi

Both the unificatory symbolism behind **Dimensiones Paradisi** – which acts internally to bind together ostensibly diverse materials within the piece while also linking it meaningfully to ‘outer’ cultural and natural objects, beyond the composition itself – and its elaborate proportionally self-similar formal structure (many aspects of which display symmetry-breaking) are encapsulated succinctly by my Programme Annotation and Performance Notes to this work:

Dimensiones Paradisi [Latin]: “measurements [dimensions] of Paradise”.

I have appropriated this rather Dante-esque sounding title from John Michell’s inspirational book **The Dimensions of Paradise: The Proportions and Symbolic Numbers of Ancient Cosmology**, an exegetical writing on sacred geometry. It demonstrates the ancient geometrical bases – founded upon the quadrature of the circle (a symbolic melding of opposites) – which unite such diverse edifices as Stonehenge, the 12 Hides and St Mary’s Chapel of Glastonbury, Chartres Cathedral, Plato’s imaginary city of Magnesia (from **The Laws**), the Earth and Moon, and – in particular – the Celestial City (“New Jerusalem”) described by St John the Divine in **The Book of Revelation**. From their measurements, Michell evolves a complex mandala-like figure incorporating a dodecagon, several concentric circles, a hexagon, and the Star of David. This sacramental object therefore becomes the template or metaphor from which the pitch as well as the temporal data of my composition are derived, at both the macro- and micro-architectonic levels: **Dimensiones Paradisi** is, literally, that: a ‘blueprint of Paradise’ etched through vibration ... both structurally, and poetically (in terms of the nebulous, rarefied, warm, crystalline sound-world conjured up by the alto flute). Durations and lengths of sections correspond to the areas between successive shapes (moving inwards to the central point or *omphalos*), whereas the shapes’ perimeters govern pitch-gamuts (quantized to eighths). Thus, within each section, despite an infusion of some registrally anarchical tones, all pitches converge eventually to a single microtonal interval; these omphalic micro-intervals themselves implode towards the notional midpoint of the piece. Yet because, conceptually, the Arrow of Time ‘cuts across’ the generative symbol, there is a statistical tendency imposed upon the material of **Dimensiones Paradisi** to rise, inexorably, as if to Heaven...¹⁴

[TEMPORAL ORGANIZATION ...] **Dimensiones Paradisi** embraces 37 sections:¹⁵ A, B, C, D, E, F, E', D', C', B', A', G, and H; and implanted amongst these 13 lettered sections are 24 proportionally interrelated ‘interjections’ α_1 to α_8 , β_1 to β_8 , and γ_1 to γ_8 – all of which are bounded by special *intercut bar-lines*. The 10 sections A to E and E' to A' are disposed symmetrically about a brief central fragment or *omphalos* (section F); sections G and H can be thought of as a ‘coda’. (Note also that eight of these 10 sections themselves contain a central ‘sub-*omphalos*’ comprising two grace-notes!) The lettered sections are demarcated by *changes of tempo* and *ordinary bar-lines*, the latter being employed exclusively for macrostructural delineation; *dotted bar-lines* circumscribe the sub-*omphaloi*, the “pale, lunar” multiphonic subsections, and the *squared-fermata* silences (\neg). ...¹⁶

The elemental geometric data which characterize those figures behind John Michell’s symmetrical, sacramental mandala-like “New Jerusalem” design^{19b} – i.e. the ‘ground-plan of the Heavenly City’ – are encoded, ‘genetically’, into the very fabric of **Dimensiones**

Paradisi,¹⁷ so that my piece is indeed a painstakingly proportioned “voice whose sound is manifold and [a] word whose appearance is multiple. I am the utterance of my name”:¹⁸ in essence, for the first twelve of **Dimensiones Paradisi**’s thirteen lettered sections (A to G and E’ to A’), durations and sectional spans correlate to these figures’ *areas*; pitch-gamuts and -subgamuts to their *perimeters*.^{19,19b}

The following abbreviations for the foundational “New Jerusalem” patterns in **Dimensiones Paradisi** are employed within the tables and text below:

12-gon — a dodecagon (which is not quite perfectly regular);

C₁, C₂, C₃, C₄, C₅, C₆ — six concentric circles;

S — a square;

Δ — an equilateral triangle;

HS — a ‘hexagonal star’ (or hexagram), i.e. the six-pointed Star of David;

OH — its ‘outer hex’, i.e. a regular hexagon.

Those “New Jerusalem” constants that permeate **Dimensiones Paradisi** are:

Pattern	Section	Duration-Constants (ratios of AREAS)	Gamut-Constants (ratios of PERIMETERS)	Gamut-Spans (to the nearest eighthtone)
12-gon	G	D ₁ ≈ 1.018498438	Γ ₁ ≈ 1.021235027	no gamuts in sections G and H *
C ₅	A, A’	D ₂ = 1.000000000	Γ ₂ = 1.000000000	132 eighthtones = Γ ₂ × 132
C ₁	B, B’	D ₃ ≈ 0.677847709	Γ ₃ ≈ 0.823315073	109 eighthtones ≈ Γ ₃ × 132
S		D ₄ ≈ 0.532380346	Γ ₄ ≡ Γ ₃	109 eighthtones ≈ Γ ₄ × 132
C ₂	C, C’	D ₅ ≈ 0.418130546	Γ ₅ ≈ 0.646630146	85 eighthtones ≈ Γ ₅ × 132
OH		D ₆ ≈ 0.345791178	Γ ₆ ≈ 0.617486304	82 eighthtones ≈ Γ ₆ × 132
HS		D ₇ ≈ 0.230527452	Γ ₇ ≈ 0.713011768	94 eighthtones ≈ Γ ₇ × 132
Δ		D ₈ ≈ 0.172895589	Γ ₈ ≈ 0.534758826	71 eighthtones ≈ Γ ₈ × 132
C ₃	D, D’	D ₉ ≈ 0.104532636	Γ ₉ ≈ 0.323315073	43 eighthtones ≈ Γ ₉ × 132
C ₄	E, E’	D ₁₀ ≈ 0.03121756336	Γ ₁₀ ≈ 0.176684926	23 eighthtones ≈ Γ ₁₀ × 132
C ₆	F	D ₁₁ ≈ 0.0001382249740	Γ ₁₁ ≈ 0.01175691175	2 eighthtones ≈ Γ ₁₁ × 132

* NB: section H falls completely outside my sacred-proportionalized framework of pitch-gamuts and durations, being composed ‘non-systemically’ at a later date than sections A to G and E’ to A’.

In what manner, then, were these duration-constants, D₁ to D₁₁, deployed in order to establish this composition’s (lettered-section) chronomorphological macrostructure? Given a total time-span of d = 180 seconds, the beginning of section G was fixed first of all through the division of d by D₁; the duration up to this point in time (ca.176.73") therefore corresponds to the area of the circle C₅, and the span of section G itself correlates to the area between C₅ and the 12-gon. Time-spans obtained from the areas of the circles C₁, C₂, C₃ and C₄ (as well as from the areas of the remaining shapes S, OH, HS and Δ) were then computed, each being proportioned relative to the area of C₅ ∝ D₂ ≡ 1 (and *not* to that of the 12-gon); these durations were then all situated absolutely symmetrically about the midpoint of the ‘C₅ time-span’ – a grouping homologous to the concentricity of the figures

themselves within the “New Jerusalem” diagram. And yet the symmetry of this whole temporal arrangement is not quite perfect: its balance is skewed slightly by the placement of section G – and even more so by that of section H – at the end of **Dimensiones Paradisi**, as a caudal appendage (or ‘coda’). So, what would have been the total mirror-symmetry of this composition’s temporal macrostructure has thereby been *broken*. The relevant information is tabulated below:

NB: the lengths of sections A to E and E' to A' are proportional to the areas of the corresponding annuli within the “New Jerusalem” mandala.

d (the total time-span) = 180" = 144" ÷ 0.8. {In my earliest version of **Dimensiones Paradisi** for solo piccolo, now withdrawn, d was 144" = 12 × 12".} Now, let L = d ÷ (2 × D₁) = 90" ÷ D₁ ≈ 88.365378524".

Section/Figure	Durations (ideal)	Beats	Tempi	Durations (actual)	Starts at ...
A	$L \times (1 - D_3) \approx 28.47''$	≈ 39.71 ♪	♪ = 84	≈ 28.37"	0
B	$L \times (D_3 - D_5) \approx 22.95''$	≈ 40.98 ♪	♪ = 107.5	≈ 22.87"	$L \times (1 - D_3)$
S (macro-start)					$L \times (1 - D_4)$
C	$L \times (D_5 - D_9) \approx 27.71''$	≈ 40.97 ♪	♪ = 89	≈ 27.62"	$L \times (1 - D_5)$
OH (macro-start)					$L \times (1 - D_6)$
HS (macro-start)					$L \times (1 - D_7)$
Δ (macro-start)					$L \times (1 - D_8)$
D	$L \times (D_9 - D_{10}) \approx 6.48''$	≈ 13.79 ♪	♪ = 128	≈ 6.46"	$L \times (1 - D_9)$
E	$L \times D_{10} \approx 2.76''$	5.00 ♪	♪ = 109	≈ 2.75"	$L \times (1 - D_{10})$
F	2 grace-notes ≈ 0.00"				L
E'	$L \times D_{10} \approx 2.76''$	5.00 ♪	♪ = 109	≈ 2.75"	'L'
D'	$L \times (D_9 - D_{10}) \approx 6.48''$	≈ 13.79 ♪	♪ = 128	≈ 6.46"	$L \times (1 + D_{10})$
C'	$L \times (D_5 - D_9) \approx 27.71''$	≈ 40.86 ♪	♪ = 89	≈ 27.55"	$L \times (1 + D_9)$
Δ (macro-end)					$L \times (1 + D_8)$
HS (macro-end)					$L \times (1 + D_7)$
OH (macro-end)					$L \times (1 + D_6)$
B'	$L \times (D_3 - D_5) \approx 22.95''$	≈ 41.08 ♪	♪ = 107.5	≈ 22.93"	$L \times (1 + D_5)$
S (macro-end)					$L \times (1 + D_4)$
A'	$L \times (1 - D_3) \approx 28.47''$	≈ 39.71 ♪	♪ = 84	≈ 28.37"	$L \times (1 + D_3)$
G	$d - d \div D_1 \approx 3.27''$	4.75 ♪	♪ = 87.5	≈ 3.26"	$d \div D_1$
H	ca.13" + part of a full breath-length				d

However, despite the presence of some small degree of symmetry-breaking within the above plan,²⁰ I did sense that the earlier versions of **Dimensiones Paradisi** lacked spontaneity and surprise, being still too rigidly symmetrical in relation to its gamut-based pitch-structure and temporal architecture. I therefore resolved to instil life into this work, to subvert its static, crystalline symmetries much further by composing and prudently inserting twenty-four “proportionally interrelated ‘interjections’ α₁ to α₈, β₁ to β₈, and γ₁ to γ₈”²¹ whose pitches are “registrally anarchical”²² in that they are never regulated by any of my gamut-schemata. Unity is, notwithstanding, retained – since the time-spans of these interjectory α-, β- and γ-sections all stem from the very same “New Jerusalem” duration-constants. (The three distinct classes of Greek-lettered sections are themselves proportionally interlocked even more tightly by another property: the lengths of sections β₁

and α_2 are identical, as are those of sections γ_1 and β_2 .) In my definitive recasting of **Dimensiones Paradisi** for alto flute, these twenty-four additional “interjections” expanded the piece through a number of musical ‘dimensions’, perhaps most of all by breaking pre-existent symmetries in both the time- and gamut-domains.

The α -, β - and γ -sections’ durational data and interrelationships are set out below:

Section	Time-Spans (in seconds)	Section	Time-Spans (in seconds)	Section	Time-Spans (in seconds)
α_1	36.00000000" = α *	β_1	24.40251752" $\approx \alpha \times D_3 = \beta$	γ_1	16.54119060" $\approx \beta \times D_3 = \gamma$
α_2	24.40251752" $\approx \alpha \times D_3 = \beta$	β_2	16.54119060" $\approx \beta \times D_3 = \gamma$	γ_2	11.21240815" $\approx \gamma \times D_3$
α_3	19.16569246" $\approx \alpha \times D_4$	β_3	12.99142072" $\approx \beta \times D_4$	γ_3	8.806204773" $\approx \gamma \times D_4$
α_4	15.05269966" $\approx \alpha \times D_5$	β_4	10.20343798" $\approx \beta \times D_5$	γ_4	6.916377056" $\approx \gamma \times D_5$
α_5	12.44848241" $\approx \alpha \times D_6$	β_5	8.438175281" $\approx \beta \times D_6$	γ_5	5.719797782" $\approx \gamma \times D_6$
α_6	8.298988272" $\approx \alpha \times D_7$	β_6	5.625450187" $\approx \beta \times D_7$	γ_6	3.813198521" $\approx \gamma \times D_7$
α_7	6.224241204" $\approx \alpha \times D_8$	β_7	4.219087640" $\approx \beta \times D_8$	γ_7	2.859898891" $\approx \gamma \times D_8$
α_8	3.763174896" $\approx \alpha \times D_9$	β_8	2.550859482" $\approx \beta \times D_9$	γ_8	1.729094256" $\approx \gamma \times D_9$

* NB: this duration *approximates* my full breath-length when softly blowing an alto flute.

In ordering the twenty-four α -, β - and γ -sections and in deciding exactly where they were to be inserted into my original nearly-symmetric macrostructure, what criteria did I bring into play? Beyond basic ‘compositional instinct’ and other such inarticulables, I recollect that I was keen to conjure up some formal ambiguity within **Dimensiones Paradisi** by way of what one might call *cognitive symmetry-breaking*: sections ‘as written within the score’ are not necessarily heard as such (at least by me), in that certain listeners may perceive what to them appears to be a section beginning *somewhere between* the intended frontiers of my ‘on-paper’ sections. For instance, my iconic and recurrent “no air! tube resonance and mechanism noise only!” gestures – the first of which in fact launches **Dimensiones Paradisi** – are “important cognitive/structural anchor[s] – a kind of ‘ritornello’ – in [this piece]”²³ which seem, aurally, to imprint themselves as moments of onset (even as sectional openings) upon a listener’s mind, whether they are meant as such or not. Likewise, after fugitive air-noises at the start of section α_1 (p.13) that muffle the foregoing section into fifteen seconds of silence, the first of α_1 ’s soft, burbling, randomized multiple trills will probably be heard as a beginning – although it speaks at about 52% of the way into section α_1 . And the openings of some of the γ -sections – for example, sections γ_1 (p.7), γ_6 (p.2), and γ_5 (p.4) – audibly conform to, and so extend, the preceding sections’ gamut-schemes provisionally (perhaps giving the impression that one is still apprehending music from the previous section?), before they culminate this deception by ‘breaking out’ altogether into other registers, well beyond the gamut. Such musical legerdemain undermines symmetry at a cognitive level, by rendering some degree

of ambiguity between what is composed (as evinced within my score) and what may well be perceived by an audience.

As with **Dimensiones Paradisi**'s temporal macrostructure, symmetry-breaking also manifests itself comparably *within my system of gamuts*, because they are nowhere centred upon the precise midpoint, $G\flat 4$, of the global gamut $D\flat 3 — B\flat 5$: instead, my *omphalos* gamut (which, as one would expect, governs **Dimensiones Paradisi**'s *omphalos* – the central two grace-notes within section F) is $C\flat 4 — C\sharp 4$. Moreover, the sub-*omphaloi* gamuts within the eight lettered sections A to D and D' to A' are similarly skewed away from the midpoints of these sections' main gamuts. For example, the overarching gamut of section D' is $D\flat 4 — A\flat 4$; its midpoint is therefore $F\flat 4$. But the sub-*omphalos* gamut at the core of section D' is, rather, $F\sharp 4 — G\flat 4$, lying more than a quartertone above this midpoint-pitch. Thus we observe gamut-asymmetry operating in two contiguous architectonic layers – sectional and subsectional – within **Dimensiones Paradisi**. Further, since my gamut calculations were always quantized compulsorily to the nearest eighthtone, round-off errors serve to break symmetries even more – as can be gathered from the slight incongruities between certain pairs of parallel gamut-spans tabulated below:

Figure	Gamuts of Lettered Sections	Spans (in eighthtones)	Overlap	Derivation of Overlap †
C_5	$A \cup A' = D\flat 3 — B\flat 5$	$132 = 44 + 44 + 44$	44	$44:132 = 1 \div 3 = r$
	$A = D\flat 3 — C\flat 5$	$88 = 44 + 44$		
	$A' = C\sharp 4 — B\flat 5$	$88 = 44 + 44$		
C_1/S	$B \cup B' = E\flat 3 — G\flat 5$	$109 = 40 + 30 + 39$	30	$\Gamma_3 \times r \approx 30:109$
	$B = E\flat 3 — A\sharp 4$	$70 = 40 + 30$		
	$B' = D\flat 4 — G\flat 5$	$69 = 30 + 39$		
C_2	$C \cup C' = F\sharp 3 — D\sharp 5$	$85 = 34 + 18 + 33$	18	$\Gamma_5 \times r \approx 18:85$
	$C = F\sharp 3 — G\flat 4$	$52 = 34 + 18$		
	$C' = D\flat 4 — D\sharp 5$	$51 = 18 + 33$		
OH *	$= F\sharp 3 — D\sharp 5$	$82 = 33 + 17 + 32$	17	$\Gamma_6 \times r \approx 17:82$
HS *	$= E\sharp 3 — E\flat 5$	$94 = 36 + 22 + 36$	22	$\Gamma_7 \times r \approx 22:94$
Δ^*	$= G\flat 3 — D\flat 5$	$71 = 29 + 13 + 29$	13	$\Gamma_8 \times r \approx 13:71$
C_3	$D \cup D' = A\flat 3 — A\flat 4$	$43 = 19 + 5 + 19$	5	$\Gamma_9 \times r \approx 5:43$
	$D = A\flat 3 — E\flat 4$	$24 = 19 + 5$		
	$D' = D\flat 4 — A\flat 4$	$24 = 5 + 19$		
C_4	$E \cup E' = B\flat 3 — E\flat 4$	$23 = 11 + 1 + 11$	1	$\Gamma_{10} \times r \approx 1:23$
C_6	$F = C\flat 4 — C\sharp 4$	2		

* NB: the gamuts corresponding to these figures were split up (in precisely the same way as those relating to the circles C_1 , C_2 , C_3 and C_5) and were then embedded within sections C and C'.

† Besides determining all 'macrostructural gamuts' – i.e. 132 eighthtones overall for sections A & A'; 109 eighthtones in total for sections B & B'; etc. – that stem from the listed "New Jerusalem" figures, the gamut-constants Γ_3 to Γ_{10} also control the manner whereby these macroscopic gamuts are themselves cleaved into smaller, overlapping gamut-pairs. (The overt symmetry of this cleaving process is at times marred somewhat by the need to round-off all gamut computations to the nearest eighthtone.) In particular, as is evident from this table, each component of a gamut-pair corresponds to a lettered section or to its 'dashed' counterpart; the extent to which these paired gamuts overlap is closely proportional to the matching figure's gamut-constant.

Focussing now upon the *microstructure* of **Dimensiones Paradisi**, we can discern identical strategies for creating – then subverting – symmetries resident *within* its lettered sections: (a)symmetry is the principal vehicle by which the concept of multilevel architectonic self-similarity is articulated in **Dimensiones Paradisi**. Indeed, at the subsectional stratum, the very same duration- and gamut-constants assert themselves in equivalent fashion. However, whereas the “New Jerusalem” macrostructural chromomorphology of **Dimensiones Paradisi** is almost perfectly symmetric, and architectonic self-similarity implies that one should anticipate the same phenomenon evincing itself symmetrically at the microstructural tier (i.e. within lettered sections), this turns out to be the case only in an ideal, dormant sense. In sections A to D and D' to A', the expected temporal symmetry (along the lines of **Dimensiones Paradisi**'s pristine mirror-symmetric ground-plan) is utterly upset by a thorough avoidance of ‘time-span concentricity’. Such symmetry-breaking within these eight lettered sections acts to generate their internal durations and rhythmic life, because the proportionally self-similar local time-spans are never nested concentrically, with coinciding midpoints. And although grace-notes in **Dimensiones Paradisi** “all lie ‘outside time’ – locally independent of ... other metrical/durational schemata”,²⁴ in this context they do, in practice, ‘round out’ the foreground chromomorphology, serving to deliver it more accurately. For the sake of illustration, the temporal structure of section C (pp.5–7) is now enumerated below:

Section C's ‘ideal duration’ = $180'' \div (2 \times D_1) \times (D_5 - D_9) \approx 27.71119802'' = d_{\text{ideal}}$.

Section C's *actual* duration, of ca.40.97 ♪s at a tempo of ♪ = 89, is $\approx 27.61797753'' = d$.

Figure	Grace-Notes	Beats (actual)	Beats (ideal, i.e. palindromic chromomorphology)
C ₅ (micro-start)	2	2.00 ♪	$6.60 \text{ ♪} \approx d \times (1 - D_3) \div 2 \times 89 [\text{tempo}] \div 60''$
C ₁ (micro-start)	5	$\approx 4.67 \text{ ♪}$	$2.98 \text{ ♪} \approx d \times (D_3 - D_4) \div 2 \times 89 [\text{tempo}] \div 60''$
S (micro-start)	0	1.80 ♪	$2.34 \text{ ♪} \approx d \times (D_4 - D_5) \div 2 \times 89 [\text{tempo}] \div 60''$
C ₂ (micro-start)	3	1.00 ♪	$1.48 \text{ ♪} \approx d \times (D_5 - D_6) \div 2 \times 89 [\text{tempo}] \div 60''$
OH (micro-start) *	0	2.25 ♪	$2.36 \text{ ♪} \approx d \times (D_6 - D_7) \div 2 \times 89 [\text{tempo}] \div 60''$
HS (micro-start)	1	1.00 ♪	$1.18 \text{ ♪} \approx d \times (D_7 - D_8) \div 2 \times 89 [\text{tempo}] \div 60''$
Δ (micro-start)	0	$\approx 1.57 \text{ ♪}$	$1.40 \text{ ♪} \approx d \times (D_8 - D_9) \div 2 \times 89 [\text{tempo}] \div 60''$
C ₃ (micro-start)	2	$\approx 2.33 \text{ ♪}$	$1.50 \text{ ♪} \approx d \times (D_9 - D_{10}) \div 2 \times 89 [\text{tempo}] \div 60''$
C ₄ (micro-start)	5	1.00 ♪	$0.64 \text{ ♪} \approx d \times (D_{10} - D_{11}) \div 2 \times 89 [\text{tempo}] \div 60''$
C ₆ (sub- <i>omphalos</i>)	2	$\approx 0.00 \text{ ♪}$	$\approx 0.00 \text{ ♪}$
to C ₄ (micro-end)	0	$\approx 0.29 \text{ ♪}$	$0.64 \text{ ♪} \approx d \times (D_{10} - D_{11}) \div 2 \times 89 [\text{tempo}] \div 60''$
to C ₃ (micro-end)	2	$\approx 0.67 \text{ ♪}$	$1.50 \text{ ♪} \approx d \times (D_9 - D_{10}) \div 2 \times 89 [\text{tempo}] \div 60''$
to Δ (micro-end)	5	$\approx 1.14 \text{ ♪}$	$1.40 \text{ ♪} \approx d \times (D_8 - D_9) \div 2 \times 89 [\text{tempo}] \div 60''$
to HS (micro-end)	0	1.50 ♪	$1.18 \text{ ♪} \approx d \times (D_7 - D_8) \div 2 \times 89 [\text{tempo}] \div 60''$
to OH (micro-end)	8	2.25 ♪	$2.36 \text{ ♪} \approx d \times (D_6 - D_7) \div 2 \times 89 [\text{tempo}] \div 60''$
to C ₂ (micro-end) †	6	$\approx 2.17 \text{ ♪}$	$1.48 \text{ ♪} \approx d \times (D_5 - D_6) \div 2 \times 89 [\text{tempo}] \div 60''$
to S (micro-end)	10	2.80 ♪	$2.34 \text{ ♪} \approx d \times (D_4 - D_5) \div 2 \times 89 [\text{tempo}] \div 60''$
to C ₁ (micro-end)	1	$\approx 1.33 \text{ ♪}$	$2.98 \text{ ♪} \approx d \times (D_3 - D_4) \div 2 \times 89 [\text{tempo}] \div 60''$
to C ₅ (micro-end) ‡	1	11.20 ♪	$6.60 \text{ ♪} \approx d \times (1 - D_3) \div 2 \times 89 [\text{tempo}] \div 60''$

Figure	Grace-Notes	Beats (actual)	Beats (ideal, i.e. palindromic chronomorphology)
C ₅ (total)	53	≈ 40.97 ♪	41.10 ♪ ≈ d _{ideal} × 89 [tempo] ÷ 60" = b _{ideal}
C ₁ (total)	50	≈ 27.77 ♪	27.86 ♪ ≈ b _{ideal} × D ₃
S (total)	44	≈ 21.77 ♪	21.88 ♪ ≈ b _{ideal} × D ₄
C ₂ (total)	34	≈ 17.17 ♪	17.19 ♪ ≈ b _{ideal} × D ₅
OH (total)	25	14.00 ♪	14.21 ♪ ≈ b _{ideal} × D ₆
HS (total)	17	9.50 ♪	9.48 ♪ ≈ b _{ideal} × D ₇
Δ (total)	16	7.00 ♪	7.11 ♪ ≈ b _{ideal} × D ₈
C ₃ (total)	11	≈ 4.29 ♪	4.30 ♪ ≈ b _{ideal} × D ₉
C ₄ (total)	7	≈ 1.29 ♪	1.28 ♪ ≈ b _{ideal} × D ₁₀
C ₆ (total)	2	≈ 0.00 ♪	0.01 ♪ ≈ b _{ideal} × D ₁₁

* NB: OH (micro-start) coincides *precisely* with OH (macro-start)! Notice also the rhythmic and durational mirror-symmetry here with respect to its 'reflection' beyond the sub-*omphalos*, C₆ – this being, by chance, the sole instance of 'time-span concentricity' within section C.

† This duration enunciates HS (macro-start) after 1.00 ♪ + 5 grace-notes.

‡ This duration expresses Δ (macro-start) after 2.20 ♪s + 1 grace-note. Moreover, the last 8 ♪s here – i.e. the "pale, lunar" multiphonics and random air-noises – equate approximately to the time-span corresponding to C₄ (macro-total): C₄ total (ideal) = 180" ÷ D₁ × D₁₀ ≈ 5.517103542"; the actual duration here is 8 [beats] × 60" ÷ 89 [tempo] ≈ 5.393258427", with an error of about 0.12".

Symmetry-breaking in the *gamut-structure of section C*, tabled below, is, conversely, less spectacular. As within those other seven lettered sections of **Dimensiones Paradisi** (i.e. sections A, B, D and D' to A'), we see literally the same type of deviation away from its main gamut's centre, C₄4 (section C's gamut being F₃♯ — G₄♭4), as befalls this work's macrostructural gamuts: section C's sub-*omphalos* gamut is B₃♭3 — B₃♯3, reposing more than a semitone lower than its sectional gamut's midpoint-tone. However, the various *subgamuts* in sections A to D and D' to A' – each of which wields a 'statistical bias' towards those subgamut-pitches within a gamut – *are* deployed symmetrically (apart from some calculational round-off errors) in accordance with the method by which most of the macrostructural gamuts were splintered and overlapped. These sets of subgamuts are therefore proportionally self-similar to the gamuts themselves; the sectional and subsectional gamuts in **Dimensiones Paradisi** are likewise proportionally self-similar, across macro- and micro-architectonic planes.²⁵ In the following tabulation of gamuts and subgamuts located within section C, all of the subgamut data have been set in bold-face type:

Figure	Gamuts of Lettered Sections	Spans (in eighthtones)	Overlap	Derivation of Overlap
C ₂	C ∪ C' = F ₃ ♯3 — D ₄ ♯5	85 = 34 + 18 + 33	18	Γ ₅ × r ≈ 18:85
	C = F ₃ ♯3 — G ₄ ♭4	52 = 34 + 18		
OH	= F ₃ ♯3 — D ₄ ♯5	82 = 33 + 17 + 32	17	Γ ₆ × r ≈ 17:82
OH in section C	= F ₃ ♯3 — G ₄ ♭4	50 = 33 + 17		
HS	= E ₃ ♯3 — E ₄ ♭5	94 = 36 + 22 + 36	22	Γ ₇ × r ≈ 22:94
HS in section C	= E ₃ ♯3 — G ₄ ♭4	58 = 36 + 22		
Δ	= G ₃ ♯3 — D ₄ ♭5	71 = 29 + 13 + 29	13	Γ ₈ × r ≈ 13:71
Δ in section C	= G ₃ ♯3 — F ₄ ♯4	42 = 29 + 13		NB: 44:132 = 1 ÷ 3 = r.

Figure	(Sub)Gamuts *	Spans (in eighthtones) *	Derivation of Subgamuts
C ₅ (micro-start)	F#3 — D#4 — G 4	52 = 18 + 17 + 17	17:52 = r _C
C ₁ (micro-start)	G 3 — D 4 — F 4	43 = 16 + 12 + 15	Γ ₃ × r _C ≈ 12:43
S (micro-start)	G 3 — D 4 — F 4	43 = 16 + 12 + 15	Γ ₄ × r _C ≈ 12:43
C ₂ (micro-start)	G 3 — C#4 — E 4	34 = 14 + 7 + 13	Γ ₅ × r _C ≈ 7:34
OH (micro-start)	G#3 — C#4 — E 4	32 = 13 + 6 + 13	Γ ₆ × r _C ≈ 6:32
OH (<i>macro</i> -start)	F#3 — G4	50 = 33 + 17	see the previous table
HS (micro-start)	G 3 — C#4 — E 4	37 = 14 + 9 + 14	Γ ₇ × r _C ≈ 9:37
Δ (micro-start)	G#3 — C#4 — D#4	28 = 12 + 5 + 11	Γ ₈ × r _C ≈ 5:28
C ₃ (micro-start)	A 3 — B 3 — D 4	17 = 8 + 2 + 7	Γ ₉ × r _C ≈ 2:17
C ₄ (micro-start)	A#3 — B 3 — C 4	9 = 4 + 1 + 4	Γ ₁₀ × r _C ≈ 1:4
C ₆ (sub- <i>omphalos</i>)	B3 — B3	1	
to C ₄ (micro-end)	A#3 — B 3 — C 4	9 = 4 + 1 + 4	Γ ₁₀ × r _C ≈ 1:4
to C ₃ (micro-end)	A 3 — B 3 — D 4	17 = 8 + 2 + 7	Γ ₉ × r _C ≈ 2:17
to Δ (micro-end)	G#3 — B 3 — D#4	28 = 12 + 5 + 11	Γ ₈ × r _C ≈ 5:28
to HS (micro-end)	G 3 — B#4 — E 4	37 = 14 + 9 + 14	Γ ₇ × r _C ≈ 9:37
to OH (micro-end)	G#3 — B 3 — E 4	32 = 13 + 6 + 13	Γ ₆ × r _C ≈ 6:32
to C ₂ (micro-end)	G 3 — B 3 — E 4	34 = 14 + 7 + 13	Γ ₅ × r _C ≈ 7:34
HS (<i>macro</i> -start)	E#3 — G4	58 = 36 + 22	see the previous table
to S (micro-end)	G 3 — B 3 — F 4	43 = 16 + 12 + 15	Γ ₄ × r _C ≈ 12:43
to C ₁ (micro-end)	G 3 — B 3 — F 4	43 = 16 + 12 + 15	Γ ₃ × r _C ≈ 12:43
to C ₅ (micro-end)	F#3 — B 3 — G 4	52 = 18 + 17 + 17	17:52 = r _C
Δ (<i>macro</i> -start)	G 3 — F#4	42 = 29 + 13	see the previous table
Section C	F#3 — G 4	52 = 34 + 18	see the previous table

* NB: subgamut data are set in **bold-face** type.

For anyone who would contend that the impact of all of this symmetry-breaking within **Dimensiones Paradisi** fatally compromises the integrity of (and so the timeless cosmological meanings behind) its archetypal “New Jerusalem” diagram, I reply that – beyond my certainty that much of this piece’s dynamism flows directly from such ‘subversions’ or ‘imbalances’ – any of its symmetrical systems which might be undermined subsequently during the creative act nevertheless still reside within my composition, albeit in a latent state. Symmetry-breaking and the disruption of process thereby remains a potent technique that in no way negates symbolisms or unity.

1.2.6 VERBAL DIRECTIVES

In relation to twentieth-century compositions, it has long been accepted that *words* are a legitimate tool for the notation of music. Being part of our prodigious modern notational armoury, words comprise just one of the many types of code currently available for the deployment of ideas by contemporary composers in their scores. Indeed, there exist ‘text pieces’, such as those by Karlheinz Stockhausen and La Monte Young, whose symbologies consist entirely of words: Young’s **Composition 1960 #10**, for example, merely asks its interpreter to “draw a straight line and follow it”; the score of Harold Budd’s **The Candy Apple Revision** (1970) furnishes the ambiguous aphorism “D-flat Major” as its sole instruction.¹ The furthest that I have travelled along this path within **A World of Becoming** is to render the “Performance Instructions” of **Cosmos (One Note)** purely in words; they all fit onto one A4 ‘score-page’, along with my Programme Annotation (and my advice for entering data into the Yamaha DX7 keyboard synthesizer):

[PERFORMANCE INSTRUCTIONS] Having preselected the DX7 voice *ShanEvol 1*, depress the “Middle C” (C3) key – only – with the *strongest possible attack*! Now stay perfectly still, statue-like, holding this key down until the sound definitely ceases to evolve – after approximately four minutes. Wait a few moments longer, then *furtively* release this key, remaining as quiescent as possible until several seconds have elapsed *after the sound has finally faded into total inaudibility*. (The piece is over when you relax, at last.)

Although superficially, this ‘text score’ may seem to be just as indeterminate as the Young and Budd examples quoted above, one must remember that the DX7 voice itself (which I created, and whose parametric details append the score-page of text) is completely responsible for the minutiae of this composition’s sound-development. On closer analysis of my text, furthermore, it will also be discerned that the only scope for performative variation by players lies in their timing of the key-release and the moment they choose to finally relax.

I have also written a subsection of another piece in unalloyed ‘text notation’. On p.3 of the score of **Solar Dust: Orbits and Spirals**, a single filigree passage – itself notated somewhat normally on a five-line stave, as usual – is repeated numerous times while continuously undergoing some rather straightforward transformations. However, these metamorphic processes, which reach their zenith in ‘performer overload’, are not explicitly notated (in the same precise, emblematic manner as the repeated music itself), but are instead documented verbally, thereby permitting quite considerable interpretative leeway by the mandolinist:

Repeat the material incessantly, for at most approximately 3 minutes! Imperceptibly raise all dynamic levels [until every note is] *f poss.*! Very gradually and smoothly

increase the tempo and tension [to] AS FAST AND AS TENSE AS POSSIBLE! Push yourself and your instrument to the limit! At such high tempi, some rhythmic distortion together with performance errors such as wrong notes, incorrect techniques as well as various string and plectrum noises will surely occur. Do not worry unduly about this, and ABSOLUTELY do not lower the tempo: such ‘mistakes’ in moderation greatly enhance the piece! [The ‘feel’ at this climactic point is characterized as] Wild, ecstatic and vibrant – with extreme virtuosity and flair! TRY to maintain rhythmic accuracy WHEREVER POSSIBLE, if necessary sacrificing the given timbral details (precise plucking position, vibrato etc.). At any rate, the main objective here is to maximize excitement – so really “go for it”!

Continue to repeat the material incessantly, for at most approximately another 3 minutes! Gradually lower the dynamic level [through to the] (dynamics as given originally) [thence to] *mp* ... Steadily decrease the tempo and tension [through to the initial tempo of] (metronome \leq ca.64) [thence on to] Infinitely slow, distant and calm: NO SENSE OF PULSE! Place the notes approximately as given relative to one another ... [ca.45 seconds beyond the climactic region, the ‘feel’ is described as] Very precise, calm, resonant and impersonal. A return is made to the material as stated initially. Now also, for at most approximately 2 minutes, allow the rhythm to progressively degenerate and become imprecise, at the same time gradually transforming this material into the following final utterance: ...

Beyond these examples, I do not propose to reflect upon the usage of words in scores when they merely supplement and explicate more conventional music notation, since this textual rôle is utterly commonplace. Yet one development does deserve more than a passing mention. Whereas during the nineteenth century, composers often affixed adjectives to tempo-terms in order to attempt a succinct portrayal of the music’s mood, nowadays, for certain composers, such descriptive functions have been intensified, multiplexed, and elevated almost to the point of manneristic obsession: from recent scores, one regularly unearths prolix yet exotic, whimsical, mystical, or enigmatic verbal pronouncements. I confess that such ‘poetics’ have been liberally peppered throughout most of my own scores herein. But besides shedding light upon a composer’s interests, alliances and psychological make-up, they do convey serious messages and so fulfil reasonable objectives. My own ‘poetic commentaries’ – particularly those inscribed at the outset of a score – divulge composerly intent in that they seek to evoke vivid images which capture the music’s atmosphere and tone; as such, they therefore become crucial interpretative props for accomplishing ‘authentic’ performance practice.²

Some of the ‘picturesque directives’ – colourful, even arcane, inscriptions (always in English) – that I have attached to my scores include: “Stone-like, hieratic and inexorable”;³ “monolithic: cloyingly lyrical...”;⁴ “Icy cold: a dead, still sound”;⁵ “Starry and shimmering”;⁶ “Extremely slow, infinitely calm and ritualistic, with a sense of suspended time”;⁷ “a remote (and receding) tintinnabulation of chord-tones, somewhat obscure yet lyrical, like sanctus-bells”;⁸ “rolling thunder, infinitely remote” and “radiant, auroral”.⁹ Within **Lines of Light: Seven Improvisations on αιθερος μελος**, improvisations 3 to 6 are each headed

respectively by the following rubrics: “A complex interplay of photons: brilliant, expansive and volatile”; “... like all-embracing waves of light!”; “Free and spacious – cosmic”; and “Infinitely placid, timeless”.

In themselves, none of these captions are really signficatory beyond their inherent evocativeness; others, however, also hint at my deeper compositional motives. The opening sections of **Dimensiones Paradisi** and **Lines of Light: Seven Improvisations on αιθερος μελος** I myself envisage as ‘Creation myths’ – ‘cosmogonies’ etched in sound – a notion undergirded by both of these works’ initial metaphoric descriptors: “Incantatory: ‘a coalescence of interstellar matter...’”,¹⁰ and “A volcanic yet ephemeral texture: glittering unceasingly, with great luminosity and searing heat (bubbling lava, solar flares, core of the sun...)”.¹¹ Likewise, the percussion instruments’ representation of responsive Divinity in **153 Infinities** is openly declared by: “A glittering ecstasy: unceasingly brilliant, like ‘divine speech’ (in answer to prayer); infinitely radiant, luminous and bubbling; an avalanche of light!”.¹²

Rubrics such as these can even become structural referents, or (occasionally rather cryptic) verbal clues that may be deciphered to identify the compositional artifices at play. Both the celestial sound-world and the long-range cyclical structure of the main section of **Cycles of Vega** are acknowledged by “Extremely slow, distant and dream-like: timeless and inexorable, but rhythmically precise, like a huge cosmic clockwork”,¹³ whereas a disruptive symmetry-breaking device is pinpointed later on in this piece by “An (uncoordinated) interruption in the process, like a brilliant, blinding, coruscative wave of light!”.¹⁴ The presence of ‘polygonal rhythms’¹⁵ that arise from, and so are emblematic of, basic geometric shapes in **153 Infinities** is signalled by “‘tolling bells’ (in arithmetic series)”¹⁶ and – rather more obliquely – by “Terrifying (in its inexorableness and symmetry): geometries of the Abyss!”.¹⁷ The formal design of **Dimensiones Paradisi** and certain sections of **153 Infinities** stem from “a complex mandala-like figure incorporating a dodecagon, several concentric circles, a hexagon, and the Star of David”¹⁸ whose central point, or *omphalos*,¹⁹ is

[in] the myths of various peoples, ... a symbol of the center of the world from which creation is supposed to have originated. The omphalos of Delphi is famous; it is a cylindrical stone with a rounded top that was also a symbol of the connection between the realms of the gods, of man, and of the dead. The pole star is sometimes thought of as the navel of the sky around which the heavens seem to rotate.²⁰

The ‘structural cores’ of these pieces are therefore labelled “‘omphalic!’”²¹ and “Omphalic (of the Universal Axis, the “Navel of the Earth”) ... infinitely fluid”.²² Raphael Patai further explains the significance of the *omphalos* within Jewish mythology:

In the middle of the Temple [of Jerusalem], and constituting the floor of the Holy of Holies, was a huge native rock which was adorned by Jewish legends with the peculiar features of an *Omphalos*, a Navel of the Earth. This rock, called in Hebrew *Ebhen Shetiyyah*, the Stone of Foundation, was the first solid thing created, and was placed by God amidst the as yet boundless fluid of the primeval waters. Legend has it that just as the body of an embryo is built up in its mother's womb from its navel, so God built up the earth concentrically around this stone, the Navel of the Earth. And just as the body of the embryo receives its nourishment from the navel, so the whole earth too receives the waters that nourish it from this Navel.²³

It is not a coincidence that Patai's 'embryonic analogy' here is also an elegant summary, a puissant encapsulation, of the compositional strategies, force-fields, and ground-plan that gave rise to **Dimensiones Paradisi**; and so the symbolism behind my "omphalic" score-captions above is by no means fortuitous either. I shall now highlight several additional instances of florid verbal descriptors that evince underlying symbolisms in my scores.

As implied by its title (and stated candidly within its Programme Annotation), there are intimate correspondences – tangible as well as metaphoric – between rainbows and the music of **Arc of Light**. The caption at the beginning of its score stresses this link: "Monolithic, but glistening like a rainbow: hieratic. 'Music of the Spheres'".²⁴

Similarly **[p]s(t)ellor/mnême**, whose abstruse Graeco-Latin name accommodates the idea of 'astral memory',²⁵ utilizes an homologous verbal ruse to symbolize periodic astronomical phenomena such as Earth's leisurely cycle of precession, from which this piece's chronomorphology is calculated: "Inexorable (like an orrery), hieratic, luminous: beautiful and cosmic, yet with a distant strangeness..."²⁶

But it is perhaps within the score of **Dimensiones Paradisi** that 'poetic-symbolic directives' reach consummation, through reference to heavenly bodies and thus, by corollary, to their many semiotic counterparts. Within this work, there are eight subtle passages of multiphonics which are each marked "pale, lunar: one fluid gesture";²⁷ the spans of these gleamy multiphonic subsections generally speaking are all correlatives of certain small circles that symbolize our Moon within **Dimensiones Paradisi**'s foundational 'mandala'.²⁸ The Moon itself

plays an important role in the magical and graphic symbolic thought of most peoples. In this regard, it is especially important that the Moon appears to "live" due to its constantly changing shape, that it is apparently associated with various life rhythms on the earth, and that it became an important fixed point in the measurement of time. In the ancient Orient, it thus often played a more significant role than the Sun. Among many peoples, it was revered as a god or (usually) goddess (such as among the Greeks, who knew it as Selene, and among the Romans, who knew it as Luna). Because of its "waning" and "waxing" and its influence upon the earth (especially upon the female body), it has been associated with female fertility, rain, moistening,

and with all becoming and passing in general since time immemorial. Among some peoples, there were certain rites that were supposed to strengthen or rescue the Moon during the phase of the new moon or lunar eclipses, which were thought of as weaknesses of and threats to [this] nocturnal heavenly body. In contrast to the self-luminescent Sun, which is usually interpreted as being masculine and is closely related to the Yang principle ... the Moon usually appears as a symbol of that which is gentle, in need of support, and feminine, and is usually associated with the Yin principle. ... In many myths, the Moon appears as a sister, woman or lover of the Sun. In astrology and in depth psychology, the Moon is thought of (among other things) as a symbol of the unconscious, of fertile passivity, and of receptivity.²⁹

The score of **Dimensiones Paradisi** also displays several textual instructions that instead invoke Mercury in its various forms – planet, chemical element, and Ancient Roman god – and consequently Hermes, Hermetic doctrines, alchemy, and the idea of macroscopic-microscopic self-similarity (which is of course manifested by **Dimensiones Paradisi**): “mercurial...”,³⁰ “quicksilver!”,³¹ “Crystalline, luminous/numinous, quicksilver...”.³² Let us now seek out some of the pertinent mercuric symbolisms. Mercury was the

Ancient Roman God of trade (later identified with Hermes). [Mercury is the name] of the planet closest to the Sun; in alchemy, Mercury is the sign for quicksilver (the earthly counterpart of the planet) and for *materia prima* (primeval matter) as well as for the Philosopher’s Stone. Next to salt and sulphur, mercury is considered in alchemy to be one of the “philosophical” elements and world principles; it represents the ephemeral (spiritus). In contrast to the “masculine” planets Sun, Mars, Jupiter and Uranus and the “feminine” planets Venus, Saturn and Neptune, Mercury was interpreted as hermaphrodite; it thus played an important role as a symbol of all practices of alchemy that mediate opposites.

In ancient mythology, Hermes was the god of trade and commerce; as a messenger of the gods, he held Caduceus in his hand. Astronomically and astrologically, Hermes was known in antiquity as the planet ... that could be seen by all with the naked eye but that was the most difficult to observe (only in the morning and evening skies near the sun). Hermes is quicksilver in alchemy and metal and Mercury in astrology.³³

Although the fantastic directive for section α_2 in **Dimensiones Paradisi** – “Like freshly cut steel: extremely pure, brittle, bright, innocent ... glossolalia! (In one breath...)”³⁴ – would, at first blush, ostensibly be unrelated to the foregoing matrix of associations, this turns out not to be the case: in antiquity, there was an alchemical bond between steel and the planet Mercury.³⁵

Finally, one of the last of **Dimensiones Paradisi**’s ‘planetary poetics’ – “‘Music of the Spheres’: bursting upwards, through crystal orbits...”³⁶ – accompanies an ascending legato phrase of ever higher, overblown harmonics. To my mind, the union of these words with a harmonic series perspicuously symbolizes a soul that, having transcended its earthly shackles, penetrates in succession each of the eight harmoniously vibrating Platonic spheres (which bear all celestial bodies),³⁷ and then soars on to God in Heaven.³⁸ But I must emphasize that this image is not exclusively Platonist: these “spheres” could equally

be the three 'heavens' of Christianity,³⁹ or even the Gnostics' regions of archontic dominance:

The Gnostic believed that at death, his soul would ascend beyond the earth and on, though occasionally obstructed by archons or starry 'governors', to the source of 'Light' within the Pleroma of the Father. In Alexandria, this possibility was seen as one which might be enjoyed before death. The **Discourse on the Eighth and Ninth** in the Nag Hammadi Library [ed. Robinson (1990)] describes such an ascent and the wonder of revelation that accompanied it ...⁴⁰

1.2.7 RANDOMIZED PARAMETERS

Almost all musics across our planet today, irrespective of their traditional lineages or cultural origins, demand some kind of impromptu improvisational output from performers. Whenever there is some notated component (as in a standard jazz chart, with its melody and chord symbols), the interstices between sketchy notation and sonic effect – the ‘missing information’, as it were – are often bridged by musicianly adherence to pre-established performance practices, the boundaries of which determine each ‘style’. Alternatively, after sufficient scrutiny of the germane issues, one can isolate *musical parameters* – these are rooted upon instruments’ technical capabilities and physiologies, or upon other compositional variables – which may then be treated freely, or *randomized*, to become the substrata for delimited improvisation. In **A World of Becoming**, the most Daedalian manifestations of ‘randomized parameters’ have been notated predominantly through *words*. But in two of the earlier compositions of mine herein, **Arcturus Timespace** and **Cycles of Vega**, I have engaged randomization in a quite rudimentary fashion, rather cosmetically and sporadically, with parameters such as the speed or note-order of trills:

[RANDOMIZED PARAMETERS] “Rand.” denotes the random treatment, over a specified duration, of individual, clearly indicated technical/musical parameters. Such parameters operate independently of one another when more than one parameter is so engaged. “Rand.” may be applied to the trilling-action of a (sub)set of fingers in a clarinet fingering, to the frequency modulation (i.e. speed-changes) in a trill or clarinet key-vibrato, or to the vibraphone’s vibrato-rate between given upper and lower limits, for instance.¹

However, within **Dimensiones Paradisi**, the influence of such randomness and indeterminacy is broadened considerably – and is woven more naturally into the fabric of the music – by being assimilated into a much wider array of technical resources for the alto flute: random air-noise; random whistle tones; “no air! tube resonance and mechanism noise only!”; overblowing – as well as trilling activity. In most cases, the nuances of randomization are fully elucidated within the score’s Performance Notes, an exception being those sequences of randomly flickering microtonal multiple trills from sections α_1 and α_2 :

a complex random trilling action involving the D and/or D# trill keys (speed: ‘fast’ to ‘as fast as possible’). The presence of the four pitches in each trill should be statistically equal, each pitch appearing approximately 25% of the time, without any bias towards the initial pitch.²

But ever since the early 1990s, when I first became a novice improviser after joining Roger Dean’s new-music ensemble *austraLYSIS* (whose repertoire ranges from the meticulously notated complex edifices of Brian Ferneyhough through to ‘free

improvisation'), my attitude towards compositional randomness and 'comprovisation' has undergone substantial refinement. **Lines of Light: Seven Improvisations on αιθερος μελος** and **Zodiac: Crystal Orbit Improvisations** were both commissioned by Roger Dean for performance by *austraLYSIS* with the tacit expectation that each work would feature some form of improvisation. So, my composerly response to this challenge (having furnished their primary musical source-materials) was to carefully itemize each player's randomizable parameters with a view to "provid[ing] an improvisational stimulus ... while framing the artistic boundaries within which the music can unfurl. My aim is simply to provoke diverse musicality and spontaneous invention within a ... [preordained] structure".³ The archetypal symbological protocol that I devised for 'randomized parameters' in these compositions is proclaimed in full within the Performance Notes to **Lines of Light**:

[RANDOMIZED PARAMETERS] Within each of the three instrumental parts which comprise **Lines of Light**, a number of technical/musical parameters are bracketed thus: *Rand { }*. Until countermanded by some other randomization directive, all of these bracketed parameters may be randomly transformed, introduced, or eliminated in performance. As such, they provide an improvisational stimulus to the players while framing the artistic boundaries within which the music can evolve. Related 'curly bracket notations' involving randomized parameters are:

+*Rand { }* – add these bracketed parameter(s) to the previous *Rand { }* directive;

–*Rand { }* – subtract these bracketed parameter(s) from the previous *Rand { }* directive;

End Rand { } – end the randomization of these bracketed parameter(s);

End Rand – end *all* randomization of technical/musical parameters: *Rand { }* is concluded.

Whenever *Rand { }* is in operation, any technical instructions notated between parentheses – () – take mandatory precedence, locally and temporarily overriding the randomization process. For instance, a sonority assigned the dynamic indication (*ppp*) during a passage when *Rand {p↔mf}* is functional, *must* be played in *ppp*, irrespective of this particular *Rand { }* directive!⁴

By way of example, the 'randomized parameters' for the keyboard synthesizer part in **Zodiac: Crystal Orbit Improvisations** are:

Randomize: {(multi)octave transpositions; the addition of unspecified material; the (s)pacing of events (i.e. their speed and density); textures (e.g. single tones, chords, grace-note groups, arpeggiation, tremoli...); durations of key-depression; key-velocities; the depression and release of the sustaining pedal; the pressing down and lifting up of the volume pedal; manipulations of the pitch-wheel; the activation, transformation, and neutralization of microtonal keyboard settings (i.e. equal-tempered microtones, or unequal [historical] temperaments)}

Note: the randomization of *portamento* is optional.⁵

In contradistinction to the intermittent ‘randomized parameters’ of **Arcturus Timespace** and of **Cycles of Vega**, the randomization within **Zodiac: Crystal Orbit Improvisations** suffuses the whole work continuously, as an integral facet of its ‘compositional identity’. And apart from its final section, exactly the same can be said about **Lines of Light: Seven Improvisations on αιθερος μελος**. This piece, however, also exhibits an extra structural dimension in that the randomization process itself constitutes a compositional ‘meta-parameter’: by regulating the amount of randomness (gradually decreasing it across **Lines of Light**, so that fewer parameters are randomized within each successive “improvisation”), I have forged a trajectory of evolution from ostensible amorphousness (‘primordial chaos’) in its opening “improvisation”, through to formal clarity (‘order’) at its last section, “αιθερος μελος : μελος φωτος”, from which all randomization has been utterly banished:

... the first six “improvisations” in **Lines of Light** – whose basis-materials nonetheless stem from the fully composed *αιθερος μελος* – were planned to fill out 485 seconds, proceeding from ‘chaos’ to ‘order’. (485 ≈ IEQY, the Greek mystics’ *Tetragrammaton*, equivalent to the OM of Eastern cosmogony. Also, not insignificantly ... 485 ≈ ‘Ο Παναγιος: The All-Holy.’) ...⁶

The ‘randomized parameters’ encountered in **[p]s(t)ellor/mnême** parade the same kind of text-based symbology as has been witnessed in **Lines of Light: Seven Improvisations on αιθερος μελος** and **Zodiac: Crystal Orbit Improvisations**. However, except for the soloist’s part here (which is closely consanguineous to the soprano recorder part in **Zodiac**), any parametric randomization amongst the instrumental consort merely serves as an ornamental ‘overlay’ that is not really intrinsic to the whirlpool of compositional mechanisms at play: much of the broken consort’s musical material is already quite explicit – all pitches and timings, for example, have been preordained – so that there exists little latitude for true improvisation by these musicians. Yet the permissible randomizing within their parts does allow for some ‘embellishment’ (as a modern parallel to early-music performance practices), thereby according a consort the opportunity to grapple with ‘bounded liberty’, and so stamp their own distinctive personality upon their interpretation of **[p]s(t)ellor/mnême**. (Even so, were the consort-parts’ potential for randomization to be neglected – at worst being executed quite literally, with no ‘random ornaments’ – then I doubt whether the soundscape or the structural integrity of this work would be seriously threatened.)

A profound question now needs to be asked, at last: what does compositional randomness actually *mean*? For me – within every one of my pieces cited in this subsection – parametric randomization symbolizes cosmological entropy, as well as the uncertainties or unpredictabilities embraced by both Chaos Theory and by the ideas

behind Quantum Mechanics (such as the Heisenberg Uncertainty Principle);⁷ these scientific paradigms are all fundamental ingredients of our modern world-view.

1.2.8 NETWORKS OF CUES AMONGST PERFORMERS

Within my compositions in **A World of Becoming**, the establishment of *networks* – some of which are, I admit, decidedly basic – *of visual or aural cues between players* serves in each case at least one of four purposes; these signal-functions are not at all mutually exclusive.

Surely the most elementary goal of cueing is simply to achieve accurate coordination among musicians. In **Arcturus Timespace**, the soloist cues the sound-projectionist (at the end of the instrumental introduction) to start play-back of the pre-recorded synthesized sounds at a specific moment. Likewise, towards the conclusion of this piece, the soloist gives a signal to the image operator to ‘dissolve’ the penultimate photograph’s projection into the final shot – a visual ‘cross-fade’. (However, if these personnel are able to follow the score correctly, then both cues do become redundant.) The situation in **Lines of Light: Seven Improvisations on αιθερος μελος**, though, is a little more involuted, because interactive cueings with various degrees of temporal independence or elasticity amongst the performers are integral to the conception of this work:

Throughout each part in **Lines of Light: Seven Improvisations on αιθερος μελος**, instructions are provided for *cueing one another* – *to coordinate, at a given moment, the attack (or the ending) of a sonority with another player or instrument*. Such instructions occur in two cognate forms: *a large bold arrow pointing downwards*, which signals the instant when *everybody* must coordinate with one another (NB: this ‘generalized cue’ occurs almost exclusively within the final [tutti] section of **Lines of Light**, section 7); when such an arrow also has *the name of another part or another instrument written directly above it*, the performer must coordinate with that particular player or instrument (only) at the given instant. All executants are encouraged to discover, thence to notate within their own parts, additional points in the music when cueing one another might prove salutary.¹

A more aesthetically satisfying use of visible cues, I believe, is to add another level of meaning to an instrumental work by injecting into it an element of theatre through expressive physical action. For instance, after seven seconds of complete immobility before the dénouement of **153 Infinities**, the pianist is instructed to “lift your hands, bringing them together in an attitude of prayer. This gesture will also serve to cue the percussionists and lighting crew, if present”.² In a live concert, the pianist’s supplicatory hand-movement here is quite poignant and poetic. Yet it also fulfils a mundane coordinative rôle:

Ideally, only a small area encompassing the piano and pianist should be spotlighted, with the rest of the performance space – in particular, the percussion instruments and their players (if present) – remaining in total darkness, unseen. At the pianist’s cue near the end of the piece (viz. *their hands being lifted and brought together in an attitude of prayer* [p.10]), spotlights suddenly snap on all three of the ‘percussion

zones' – which must be deployed towards the rear of the performance space, remote from both pianist and audience ... The percussionists should all ***start playing together as soon as possible*** after spotlights illuminate the three 'percussion zones', thereafter ***coordinating attacks precisely*** at the beginning of each bar (i.e. at 0", 1", 6", 14", and 27").³

The elaborate staging, lighting, and instrumental dispositions within the concert hall sought after in **153 Infinities** – all of which pertain directly to just this single cue – perhaps requires justification. Metaphorically, the piano part (with all of its explosive outcries, tender murmurings, and stillness) signifies a trek of human experience that ranges through the joys and travails of life; so, in answer to a prayer, the panoply of percussion at last responds, fervently, as God:

[The (optional) percussion in **153 Infinities**] is intended to symbolize ... the three persons of the Holy Trinity. ... As an interesting aside, there is a small but growing repertoire of significant twentieth-century compositions in which a 'single Divinity' is represented by more than one musician or instrument – thereby avoiding an obvious anthropomorphism ... My own method of sidestepping both the anthropomorphic trap and any danger of idolatry in **153 Infinities** has been to illustrate the Holy Trinity through a multitude of 'abstract' percussion instruments: therefore, it is *not* the percussionists who symbolize God the Father, Jesus Christ, or The Holy Spirit, but rather the three zones of percussion instruments themselves! Nor of course does my Holy Trinity speak in any human tongue; instead, 'Divine utterance' is simulated through recurrent yet enigmatic pitch-sequences and complex – often mathematically generated – durational and timbral patterns ... a kind of dazzling non-verbal 'glossolalia'.⁴

Patterns of cues are also able to discharge more sophisticated musical rôles, such as the local determination of duration and temporal flow. Throughout bar 39 of **Cycles of Vega**, a fairly elaborate discourse of signals takes place (over a slowly decaying tam-tam resonance), wherein micro-timings are not rigidly prescribed beforehand, but are somewhat flexible – an outcome of (among other factors) the players' variable reflexes in reacting to cues as quickly as possible:

[CUEING ONE ANOTHER WITHIN BAR 39] Within each part comprising the *single, fluidly shaped macro-event* that spans bar 39 in **Cycles of Vega**, instructions are provided for *cueing or reacting to one another* – either as an instantaneous response to one musical gesture, or as a trigger for another executant to immediately perform some other musical gesture. Such 'aural catalysts' are notated as *large bold arrows*, together with the name of another instrument (and, if necessary, a technical description of what is being played upon that instrument) written nearby. Elsewhere throughout **Cycles of Vega**, all interpreters are encouraged to discover, thence to notate within their own parts, additional points in the music when cueing one another *for the sake of accurate coordination* might prove salutary.⁵

Free durations. One smooth gesture: react to one another in accordance with the given arrows; well-connected, continuous.⁶

Given raw musical data to work with as source-material, one can even design a network of cues whose interpretative rules generate the composition's global architecture (as well

as its textural progressions). In **Zodiac: Crystal Orbit Improvisations**, all spontaneous musical invention by the three performers unfurls within a formal structure governed solely by cueing:

The soprano recorder part consists of twelve 'modules', all of them commencing with a brief *optional* pause prior to a single sustained volatile 'fractalous' sonority (the $\langle \alpha \rangle$ material) – such unstable objects should sometimes last almost a whole breath-length! – which then merges into pitch-material that forms the basis for improvisation (the $\langle \beta \rangle$ material). Within each of these modules, this $\langle \beta \rangle$ pitch-material is 'repeated', orbit-like, until the recorder-player is cued, *by both of the other instruments falling silent*, to move immediately on to the next module (regardless of whether a module's pitch-material has been completed). After the conclusion of the twelfth module, the process starts all over again with the initial module. This (epi)cyclic piece finishes when the recorder-player signals the other instrumentalists to stop, after which the next module is moved to as before, but being played without any accompaniment. (The final module's pitch-material is interpreted or 'read through' just once.) **Zodiac: Crystal Orbit Improvisations** must not end before the completion of at least one 'cycle' of twelve modules.

[The MIDI wind instrumentalist and the keyboard synthesizer player] are [each] given a one-page single block of pitch-material – derived from the $\langle \beta \rangle$ pitch-materials of the soprano recorder part – upon which to improvise; these are 'orbited through' just like the soprano recorder part's twelve modules, until the recorder-player communicates the signal to stop, just before the end of the piece. Within this framework, however, *silences of indeterminate duration* are to be randomly interjected as follows: i. The MIDI wind instrumentalist (while playing on) cues the synthesizer player to stop then to resume at the point of interruption of their pitch-material. ii. The synthesizer player likewise signals the silence of the MIDI wind instrument, as well as its re-entry at the same place within its pitch-material. iii. The synthesizer player also cues the synchronous silences of both the keyboard synthesizer and the MIDI wind instrument (these silent hiatuses serving to trigger the recorder-player's progress through their 'zodiacal modules'), and the resumption of both instruments from the same location within their respective pitch-materials. ...

Note: at the beginning of **Zodiac: Crystal Orbit Improvisations**, all instruments do normally start together. (Alternatively, the MIDI wind instrumentalist and the synthesizer player might commence only after the soprano recorder's first $\langle \alpha \rangle$ 'fractal' sonority has been completed.)⁷

1.2.9 INSTRUMENTAL SYMBOLISM

Although consideration of *the symbolism of musical instruments* cannot by any means be regarded as a ‘compositional technique’, it must be said that for me, in deciding upon the instrumentation for a new piece (as part of the compositional process), instruments’ imageries and cultural associations are indeed a secondary musical criterion – after my primary concern for their actual sounds themselves. I ensure that such iconology always accords with, and so reinforces, a composition’s extramusical themes and meanings.

Being a recorder-player as well as a composer who has written for this instrument,¹ I am particularly sensitive to the recorder’s symbolism: over several centuries, it has become strongly identified with – among other things – death, the metaphysical, supernatural and religious (and thus, by extension, with things astral). **[p]s(t)ellor/mnême** and **Lines of Light: Seven Improvisations on αιθερος μελος**, both of which feature recorders prominently, were each written in memory of deceased persons and encompass astronomical phenomena; **Zodiac: Crystal Orbit Improvisations** (as can be ascertained from its title and Programme Annotation) focusses upon the Cosmos. According to Ron Skins:

Among instruments used allusively ... the recorder must rank high in the richness and depth of its associations. Along with the flute it brings with it from time’s far recesses an atmosphere of magic and mystery. More than any other instrument it is a direct extension of the human breath (and thereby, to our ancestors, of the soul), and its quiet, often owl-like sounds are conjured from a tube by nimble fingers. This has created associations with the supernatural, thus with death and religion and deep emotion ... Further on into the mainstream of Elizabethan and Jacobean drama, the recorder is continually used to create an atmosphere of the supernatural, of religion, and of death.²

Similarly, idiophones like sleighbells, the “Kenyan bell tree”, strings of bronze jingle bells,³ sanctus-bells (rung during Mass at the instant of transubstantiation), gourd rattles, *ghungrü* (i.e. Indian bell straps), sistra, the *quijada* (a ‘jawbone’ – the forerunner of our twentieth-century vibraslap),⁴ and other shakers or rattles – as well as, perhaps, by extrapolation, windchimes⁵ – are, in many cultures apparently, often sounded during worship as a sign of the numinous ... or even as ritual apotropaics.^{6,4b}

And, as I have observed within my Programme Annotation to **Cycles of Vega**, besides being a symbol of New Age sympathies, windchimes may also be seen as entropic metaphors or emblems:

... The fascinating stochastic behaviours at play within the windchimes themselves – a prominent element of the piece, simply because these instruments are so numerous – provide a metaphorical mirror for the complex tumultuousness of the

Cosmos itself: Cosmological Entropy, Chaos, and the Second Law of Thermodynamics ... as well as the seemingly random chaotic perturbations – ‘nutation’ – of the Earth’s polar axis, which wobbles periodically in conjunction with the precession-of-the-equinoxes phenomenon, itself evinced by equinoctial points retrogressing ever so slowly along the ecliptic. (Such labyrinthine concepts, exhibiting ‘disorder within meta-order’, are encapsulated beautifully by James Joyce’s neologism “chaosmos”!) ...

Metallic percussion instruments in general (such as vibraphones or crotales)⁷ – by not comprising any of the alchemical elements of ‘earth’, ‘water’, ‘fire’ and ‘air’, but whose metals are instead extracted from them – would traditionally have been connected with the Divine (through planetary correlations):

[T]he extraction of metals from ores and their refinement were a symbol of purification and spiritualization. In certain metals, the alchemists saw earthly correspondences to the individual planets, which were thought of as the seven wandering planets of antiquity. ... Scheme of alchemistic correlations between metals and planets: Sun = gold; Moon = silver; Mercury = quicksilver (in antiquity, steel and pewter); Venus = copper; Mars = iron; Jupiter = pewter (in antiquity, brass or electrum); Saturn = lead.⁸

Perhaps this reverence of metal as a sacred material originated, in antiquity, due to the smelting of iron out of meteorites:

The worship of meteorites as “stones fallen from heaven” is especially common the world over; they were thought of as a symbolic manifestation of a connection between heaven ... and earth. ... thus, iron from meteorites that have fallen from the sky is frequently considered to be heavenly and divine.⁹

Two specific instances should suffice to verify this point. Bells, which play such a pivotal rôle in **[p]s(t)ellor/mnême**, are obviously associated with Christian churches and cathedrals, and therefore with the mythologies of Christianity itself. Moreover, bells’ aura of sanctity could be held to suggest things celestial, and hence non-teleological cyclical structures like those of campanology (and also of **[p]s(t)ellor/mnême** itself); indeed, this inference could just as easily be reversed. From within an Oriental culture, too, *rin*¹⁰ – i.e. Japanese temple bells – are treated as sacred ceremonial objects that have an integral part to play in Japanese Buddhist rituals, like the *Hōyō*.¹¹ Bells are

[f]requently a symbol of the connection between heaven and earth; bells call one to prayer and remind one of obedience toward God’s laws. The sound of the bell frequently symbolizes (in China, for example) the cosmic harmonies. In Islam as in Christianity, the sound of the bell is regarded as the echo of divine omnipotence, the “voice of God” that, when heard, leads the soul beyond the confines of the mundane. It is a very common notion that bells ward off misfortune. During the late Middle Ages, magic bells played a particular role in conjuring up good spirits (white magic) of the planetary realm.¹²

Another much-favoured metal idiophone of mine, which I call the “triangle windchime”¹³ – i.e. three triangles grouped together (as a windchime) in such a way that each triangle

bangs against the others without losing much of its natural resonance – possesses a self-evident multiple-triangular geometric shape that is richly symbolic (perhaps more so than its metallic essence). Its profile automatically invokes the numbers ‘3’ and ‘9’ (being 3×3), as well as the Holy Trinity:

[3 is the] basic number of the masculine principle next to 1 (the number of the divine) and 2 (the number of the feminine); water is the [alchemical] element of 3; the triangle is its coordinate geometrical figure. The triangle and water are also associated with one another in alchemist-medical signs. 3 plays an unmistakably fundamental role in all religions. The second and third powers of three [i.e. 9 and 27] are of particular significance, ... [being] regarded as a “strengthening” of the symbolic power of 3. 3 is the basis of numerous systems and ordering schemes; thus, Christianity, for example, has the 3 virtues of faith, love, and hope, and alchemy has the 3 basic principles of sulphur, salt and quicksilver ... Divine triumvirates are known in many religions, for example in Egypt (Isis, Osiris, Horus), in Hinduism (Brahma, Vishnu, Shiva), etc. Such divine triumvirates often appear in conjunction with heaven, earth and air (which binds them together). In contrast to this, Christianity has a triune God who is often envisaged as being a unity of three persons (a trinity). As the number of fulfillment of a self-contained entirety, 3 is frequently encountered in fairy tales as the number of tests that one must withstand or riddles that one must solve, etc. In philosophy, the triad or triple-step plays an important role, for example, as the principle of mediation between thinking and being or, as in the case of Hegel, as the principle of dialectical progress (thesis, antithesis, synthesis). ...

The number 9 is the second power of 3 [i.e. 3^2] ... the amplification of the sacred 3; this is the reason why the Kyrie eleison in the Roman Catholic liturgy is repeated nine times and why there are 9 choirs of blessed spirits; 9 plays an important role in Indo-Germanic and Central Asian mythology as well, as in the case of the 9-storied pagoda, which is a symbol of heaven.¹⁴

For the assemblage of its three “triangle windchimes”, **153 Infinities** amasses a total of nine triangles, so that the number ‘27’ is alluded to by it as well:

As the third power of 3, i.e., $3^3 = 27$, [the number 27] is the amplification and perfection of 3; it is the number of the element fire ... Under favorable conditions, the Moon is visible for $3 \times 9 = 3 \times 3 \times 3$ nights.¹⁵

On the symbolism of the triangular form itself, Udo Becker asserts that:

To a large extent, the triangle shares in the symbolic significance of the number three. In antiquity, it was sometimes regarded as a symbol of light. For many peoples, it is a symbol of fire and masculine virility when its tip points upward [as with the idiophonic triangle] and a symbol of water and the female sex when its tip points downward. The equilateral triangle is often used as a sign for God or for harmony. In Christianity, it is a symbol of the Trinity (especially since the 17th century, it frequently appears in conjunction with a hand, a head, an eye, or the Hebrew name of God, Yahweh). According to popular custom, magicians and sorcerers, the triangle is an apotropaic sign. For the Freemasons, the triangle plays an important role as (among other things) a symbol of God’s strength, beauty and wisdom; of the cornerstone of the Freemasons’ temple; of the mineral, plant and animal kingdoms; of the three stages of a person’s spiritual development (*Separatio*, *Fermentatio* and *Putrefactio*); of correct speech, thought, and action; of birth, maturity and death; and so forth.¹⁶

Even for musical instruments invented during the twentieth century, older metaphors still resonate. The ethereal and other-worldly timbral caresses of a waterphone, heard throughout the final section of **[p]s(t)ellor/mnême**, manage to connote the hereafter and starry firmaments – despite the waterphone’s exploitation in film-scores from the 1970s to depict mental instability and delusional character.¹⁷ Yet new symbolisms do emerge. A striking visual image is created by the autocoil:¹⁸ for a modern spectator, its helical form clearly brings to mind the double-spiral of DNA, that involute molecular structure which contains the genetic code of each human being; but because autocoils are manufactured from steel, the above-mentioned significations of the Holy and Cosmic also remain intact (thereby invoking, through polysemy, the perennial Hermetic view of Man as the Universe in microcosm). For the helix-as-spiral, other esoteric relationships also spring forth to render the autocoil semiotically abundant:

Even in pre-historical times, the spiral was a favorite ornamental motif of controversial symbolic meaning that nevertheless is probably associated with cyclic development, the phases of the moon and their influence on water, fertility, etc., the movement of involution and evolution in the entire cosmos generally (especially the double-spiral), with recurrence and renewal, and perhaps with the labyrinth as well.¹⁹

Furthermore, like brake drums,²⁰ the autocoil was originally designed (as its name implies) to be a car- or truck-part – so one could even think of these unintendedly musical automotive sound-sources as industrial or technological icons as well, symbols of the twentieth-century machine age.

Many of these metaphorical tributaries flow together to reach their culmination, perhaps, in **153 Infinities**, whose three ‘zones’ of percussion instruments are meant to signify the Holy Trinity – as was discussed in sections 1.2.8 and 1.2.6. Aside from the intricate patterning of the percussion music itself in this piece, scrutiny of its instrumental forces will reveal that (except for the orchestral bass drum) every one of its percussion instruments is metallic, and they do span quite an extensive range of colours and categories: various bells; vibraphones, crotales, and a glockenspiel; metal windchimes, rattles and shakers; autocoils and brake drums; three “triangle windchimes”; cymbals, a tam-tam, and Javanese gongs. These idiophones’ semiologies all emphatically underscore my signification of triune Divinity within **153 Infinities**.

Finally, by introducing electronic synthesizers into my instrumental arrays,²¹ fresh, relatively unexplored sound-worlds begin to materialize: these yield a sense of high-tech modernity, of ‘looking forward’ (perhaps to things celestial) – notions underpinned by the incorporation, ever since the 1950s, of electroacoustic timbres in film sound-tracks to portray futuristic or extraterrestrial contexts. Yet because almost all of my electroacoustic

voices were synthesized through Frequency Modulation to be deliberately somewhat bell-like, 'hypervocal', or akin to – and an extension of – the sonorities of metal instruments, the old evocations of divine or cosmic genesis might, arguably, be retained. (To some degree, this nexus between metals and FM-synthesized tones is a quite natural consequence of the acoustical formulae for freely vibrating metal bars being potentially encapsulatable within the mathematics of FM.) Anyway, my attitudes are declared within my Programme Annotation to **Arcturus Timespace**:

Pascal's wonderful aphorism – “The eternal silence of infinite space terrifies me” – evokes certain images which **Arcturus Timespace** attempts to capture. Truly, I have been spellbound by astronomy, cosmology, and the Cosmos itself since I was a child – and even now, I am constantly awed when I look up at the clear night sky with all of its breathtaking beauty, brilliance and grandeur, savouring the realization that I am peering through both 'infinite' space *and* time. Is it therefore not surprising that (as a composer and as a human being) I am really not concerned with the deification of music history and the attendant compositional supplication before musical idols of the past, with petty nationalisms and benighted tribal mentalities, with grubby politics and all that is mundane ... but more with the mystical and the sacramental, spirituality, new technologies, and – in particular – with the limitless extension of sonic and artistic possibilities? I am a musician who looks primarily to the future, and the future of Mankind is *out there*. ...

... The stereophonic 'tape' part of **Arcturus Timespace** was realized at the Sydney University Experimental Sound Studio, directed by Ian Fredericks; being computer-generated, it utilizes the Frequency Modulation Algorithmic Sound Synthesis techniques of two Yamaha CX5M music computers. The *mélange* of computer timbres are mostly bell-like, possessing a glassy, metallic, or ceramic sheen (modelled to some extent upon the acoustical signatures of the percussion instruments themselves). Although I do confess that this timbral world is in danger of becoming an 'FM cliché' ... I just *love* bell sounds! In composing **Arcturus Timespace**, my intention *ab initio* was to have the electroacoustic part intermingle with, yet also extend, the sounds of the mandolin and percussion ... The percussion instruments employed in **Arcturus Timespace**, all played by the soloist, form a kind of 'sonic bridge' between the mandolin and the electroacoustic part. They include: various types of glass fruit-bowl or ceramic flowerpot-like objects (eight “clay bells”); a collection of six Korean stainless-steel mixing bowls; shell-disc, ceramic-disc, and brass-tube windchimes; and a large tam-tam. ...

1.2.10 DURATIONS DETERMINED BY INSTRUMENTAL RESONANCE OR LUNG CAPACITY

In sculpting musical events, by relying upon *the decay characteristics of instrumental sounds* to define their durations, one is able to provide specific performance directives whose outcomes are, paradoxically, unpredictable: the resonance properties of all acoustic instruments – even two of the same type – always differ from one another in some respect, however infinitesimally; and whenever dynamic levels such as ‘*pp*’ or ‘*mf*’ feature in the durational equation, they are also subject to the vagaries of interpretation by players. The rate of sound-decay can be introduced as an arbiter of time in order to subvert the ubiquity of ‘the beat’. This tactic is adopted in **Solar Dust: Orbits and Spirals**:

The durations of other pauses are determined by instrumental characteristics or other acoustical properties: “Pause until the sound is lost in the distance”; “Pause until the dynamic level falls to ‘*mp*’”; etc. A squared fermata (⌏) is given in conjunction with the verbal instruction.¹

In **Cycles of Vega**, pauses whose durations are reliant upon the ringing-on of percussion timbres also become the scaffolding within which sequences of other musical events unfold:

The durations of other pauses – given as a squared fermata alone (⌏) – are determined entirely by instrumental characteristics or other acoustical properties: e.g. “Pause until the Tam-Tam resonance is ‘*pp*’”; etc. (The appropriate textual instruction is always provided in conjunction with the squared fermata.) Sustained (approximate) durations within the ambit of such pauses are notated time-spatially – i.e. extended *beams* depict such local durations; the end of a beam indicates the termination of a (previously sustained) note.²

When such pauses are expanded to embrace the ultimate disappearance of resonances into silence, I have often found them felicitous to end a work. The final moments of **Arcturus Timespace**, **Arc of Light**, and **[p]s(t)ellor/mnême** all dissipate in this way; their scores terminate with verbal directions along the lines of ‘relax several seconds after all instruments at last become silent’.³ However, **153 Infinities** uses these ‘fade-out pauses’ to mark the endings of sections, prior to (but merging into) silences of definite length that act as structural separators:

Pauses are always notated with a **large rectangular fermata** (⌏), over which is given either **the number of seconds’ rest** or an instruction – ... **silence** – to wait until all piano resonances have decayed into complete silence before moving on. [In practice here, the pianist really needs to estimate the exact moment silence first arrives *from the audience’s perspective*, even though they themselves might still be able to hear faint sounds emanating from the piano.]⁴

By analogy, a perfectly valid attitude in approaching musical time for wind instruments centres upon the notion that from any given moment, a performer – without recourse to

‘circular breathing’ – can maintain air-activated sound on their instrument for, at most, *one full breath-length*. Because pulmonary function varies according to each player’s physique, durations that are directly controlled by breathing considerations must, fundamentally, be indeterminate. Whereas the soprano recorder’s unstable <α> sonorities in **Zodiac: Crystal Orbit Improvisations** “should sometimes last almost a whole breath-length”,⁵ the closing gesture of **Lines of Light: Seven Improvisations on αιθερος μελος** must consume an entire lung-full of air on the tenor recorder. Likewise, the flautist is instructed to finish **Dimensiones Paradisi** by “sustain[ing] the whistle tones until all breath is depleted...”.⁶ As final resolutions, such ‘expiries’ might, for some listeners, insinuate the threshold of death or transcendence into a higher realm of being – particularly for those pieces that were written *in memoriam* or are somehow cosmological and theological (as here). But beyond the compositional motivations reported earlier, the use of breath as a temporal arbiter carries other notable symbolic overtones:

Breath – A symbol for cosmic, animating forces, also occasionally for the spirit, particularly the creating spirits present at the beginning of the world. Thus, in Taoism, for example, there is the idea of nine different primeval streams of breath whose eventual confluence created physical space, which is the precondition for everything that exists. In India, the notion of a breath that permeates everything and binds together various levels of existence, plays a large role. *Atman*, the individual spiritual-eternal Self that is united with Brahma, the divine Self, at the end of spiritual development, was originally thought of as breath; in addition, the psycho-physical entirety of man unfolds into five different streams of breath that bear a strong connection with the kundalini serpent. In the Book of Genesis, God awakens with His breath the man He created; breath here symbolizes the spirit of the creator.⁷

Being fully cognizant of these allegorical and pneumatological equatings of ‘breath’ with ‘spirit’, I then resolved to designate the concluding evanescences of **Dimensiones Paradisi** as section H: the letter ‘H’ is an aspirate, pronounced with an exhalation of breath; ‘H’ personifies πνευμα (*pneuma*) – ‘wind’ and ‘spirit’;⁸ and, at least for me, ‘H’ ultimately stands for ‘Heaven’, or paradise, the domain of God and of το ἅγιον πνευμα (the Holy Spirit).

1.2.11 SETS OF DURATIONS DEFINED BY MATHEMATICAL FUNCTIONS

Accurate computation:

The gateway to knowledge of all things and dark mysteries.

– **The Rhind Mathematical Papyrus**, Egypt, ca.1650 BC.

This chronomorphic technique gives rise to a special class of proportionalized durations, wherein *sets of durational relationships all spring from a single mathematical function* that operates recursively. In composing such a sequence of durations (whose defining mathematical function can be made to impinge upon the time domain at *any* architectonic level, so that – for example – a work's sectional spans could dilate logarithmically), there are two general approaches: one might start with some smallest duration-value – a *chronos protos* which, whenever one analyses durations' ratios, is seen as their basic time-unit and so is labelled "1" – and then treat it as a monadic multiplicand, proliferating it into longer durations through the arithmetical procedure of multiplication; or alternatively, a given time-span could be (sub)divided – partitioned strictly into a collection of briefer durations that are all mathematically cognate.

However one has fashioned such durations, they may be further organized in many ways. Because they always fall in to a natural order (from the briefest duration through to the longest), they are therefore readily permutable. And different types of mathematically formed duration-sets can be combined through the tactic of 'nesting': imagine the lengthiest duration from an 'arithmetic time-series' being itself segmented according to some (other) mathematical function; durational nestings of this sort often beget additional architectonic planes in a work's temporal structure. Whenever durations are disposed into a polyphony of rhythms, one could interlock their strata so as to cause deliberate 'interference patterns', consisting of mathematically underset 'phantom rhythms', between several durations from diverse rhythmic lines: such an elusive psychoacoustical phantasmagoria sometimes inheres within the percussion music of my **153 Infinities**.¹

With this compositional technique *unity* is innate, since all of the durations are yoked together by a single generative mathematical process. But within a piece of music, what does it really *mean*? I postulate that such duration-sets are coherent emblems that point to those physical or symbolic phenomena which grow out of the very same mathematical functions: 'polygonal durations' derived from 'figurate numbers', when taken collectively, are a clear signifier of the noumenal geometric 'figure' – a polygon which, in turn, will register various cultural associations (as with a mandala). In **153 Infinities**, though, the

twenty-eight mathematically generated rhythms embedded within the percussion parts are also meant to symbolize, rather less indirectly, some of the vocabulary and syntax of ‘the language of God’ (which, within many theological systems, is thought of as being quintessentially numeric):

Nor of course does my Holy Trinity speak in any human tongue; instead, ‘Divine utterance’ is simulated through recurrent yet enigmatic pitch-sequences and complex – often mathematically generated – durational and timbral patterns ... a kind of dazzling non-verbal ‘glossolalia’.²

In each of the following subsections’ mathematical explications, it shall always be assumed that there will be $n+1$ ‘attacks’ (which define a ‘rhythm’ – within a work’s foreground, microstructural tier) or $n+1$ ‘tectonic flags’ (yielding formal [sub]sections within a piece). Anyhow, at whatever temporal level these $n+1$ interruptive puncta occur, n durations are thereby created: $d_1, d_2, d_3, \dots, d_k, \dots, d_n$. We notate their *cumulative durations* as:

$$s_1 = d_1;$$

$$s_2 = d_1 + d_2;$$

$$s_3 = d_1 + d_2 + d_3;$$

$$\dots;$$

$$s_k = d_1 + d_2 + d_3 + \dots + d_k;$$

$$\dots;$$

$$s_n = d_1 + d_2 + d_3 + \dots + d_n.$$

i.e. in general, $s_k = d_1 + d_2 + d_3 + \dots + d_k$, where $1 \leq k \leq n$.

The *total time-span* over which the n durations elapse is therefore s_n .

Finally, within certain of the mathematical formulae below, I shall write any predestinated constant value as the letter “t”.

Some Remarks Concerning Rhythmic Notation

Whenever mathematically generated duration-sets $\{d_k\}$ are conceived towards the microscopic end of the musical time-spectrum, as ‘rhythms’, a question thus arises: how can one notate them with maximal accuracy? In all circumstances this problem is fully and practicably solvable through resorting to *time-space notation* – as I did while composing **153 Infinities** and **Dimensiones Paradisi** (these being my only pieces in **A World of**

Becoming that contain such rhythmic schemata). Yet because ‘polygonal rhythms’ are *per se* an artefact of arithmetic operations carried out upon positive integers, it should always prove possible to document them unerringly in orthodox (mensural) notation too; this option might even apply to durations that constitute a geometric progression whenever the progression’s constant multiplier “t” is some simple fraction. However, rhythms whose elements have all been fabricated in strict congruence with logarithmic interrelationships can never be notated mensurally with complete precision: composers may only ever *approximate* such durations under the mensural paradigm by using ‘irrationals’ (i.e. ‘tuplets’ – in irregular groupings), or by manipulating tempo-indications:

[They] could by no means be presented with the traditional signs for durations, since these are built on a system of whole-number relationships. ... As long as we [attempt to] use the traditional signs for duration, the only possibility is to take the same sign (e.g., \circ) for all [such] time-values, and to differentiate its duration metronomically.³

Such incommensurable ‘logarhythms’ therefore need to be drawn in analogue fashion, as time-space notation, if one wants to depict them faithfully.

But unfortunately, faithful depiction in a score does not necessarily entail an exact realization in live performance – and time-space notation is, alas, quite notorious for being rendered inaccurately, on account of its intrinsically optical (rather than corporeal) orientation towards time-relationships:

... Thus, among other things, time-durations are drawn to scale, so that no attempt can be made to quantify them. Here, the beginning and end of each duration are played with much less certainty than before. Instead of ‘counting’ – dividing up the durations into quanta – the eye measures the time-proportions, and converts them into the action of playing. Optical size-relationships must be translated into acoustical relationships of durations. ... It has always been customary for [performative] interpretation to include zones within which time-values as realised deviate from those notated (in so far as the latter are measured in metronomic or ‘clock’ time) ...⁴

... it must be concluded that conventional [mensural] notation, no matter how cumbersome and alien it is as a graphic vehicle for today’s music, is still the only method which ensures that the performer will be able to reproduce exactly what he sees. Even the addition of tactus strokes [i.e. ictuses] to proportionate notation (using nonsymbolic notes) is of only limited value in this respect, considering the rhythmic complexities of today’s music. Human beings simply do not seem to possess a space perception equal in acuity to their pulse perception; if they are not given something they can count, they will not be able to play “in time”. Even the counting of a neutral tactus, i.e. a pulse unrelated to the actual meter or rhythm, is extremely difficult if the notes themselves do not symbolize countable time values.⁵

Nevertheless, I do affirm that – regardless of this predicament of potential ‘mistranslation’ by performers – such uses for time-space notation are vindicated by its hieroglyphic rôle, as a vessel which can reveal compositional morphology.

1.2.11.1 ‘POLYGONAL DURATIONS’ DERIVED FROM FIGURATE NUMBERS

Historically, *figurate numbers*¹ are the outgrowth of an ancient accounting method which – even in our own ‘information era’, dominated by the digital computer – one can still glimpse within the etymology of the word *calculation*: “... it is interesting to see again how a residue of these things remains in some of our modern words. The use of stones for tallying is seen in the root of our word ‘calculate’ which derives from the Latin *calculus* meaning a ‘pebble’. Even in comparatively modern times one finds the very simple use of stones to enumerate large collections”.²

Greek arithmeticians compiled figurate numbers additively, by accumulating small objects (such as pebbles) into ever larger, orderly geometrical shapes:

The[se] numbers are called *figurate* because early mathematicians perceived that they give the areas and volumes of certain geometrical figures when built up by discrete units. For example, if you place a number of [identical] cannon balls in the form of an equilateral triangle, with n balls in the base, then there will be $n-1$ [balls] in the row above it, $n-2$ [balls] in the row above that, and so on until you reach the apex of one ball. The total number of balls in the triangle will be the sum of the integers from 1 up to n . All such numbers are ... consequently called *triangular numbers*.³

Many other categories of number are given by the old mathematical writers. Theon of Smyrna describes the properties of primes and composites, square, oblong, unequilateral, equally-equal, unequally-equal, planar, circular, parallelogrammatic, triangular and other numerical types. Their names commonly refer to the shapes formed by numbers when displayed as patterns of dots or pebbles. We still speak of square numbers, those produced by any number multiplied by itself, though we are no longer so inclined to visualize them literally as square in form. The old method of teaching arithmetic, by showing the relationship of numbers to shapes, was designed to illustrate basic principles and to lead the minds of children into the habits of reason. One can learn by rote that square numbers are formed by adding the next in the series of odd numbers to the previous square ... but the formula only comes to life when one sees it in action [via a diagram of dots arrayed in square grids].

Every square number is made up of two successive triangular numbers, and a triangular number consists of all the numbers from unity up to a given limit; the series they form is 3 (= 1 + 2), 6 (= 1 + 2 + 3), 10 (= 1 + 2 + 3 + 4) and so on. All such numbers can be displayed as an equilateral triangle made up of units. The Tetractys, the triangular form of the number 10, had the same significance to the Pythagoreans as the Tree of Life diagram has in Jewish mysticism, both being accounted symbols of the universe, and the numbers 1 to 4 of which it is composed were said to be at the root of all creation. The apparently inconsequential words with which Plato begins the *Timaeus*, ‘One, two, three, but where is the fourth?’, have been claimed as an allusion to the primary importance of the Tetractys in the numerical philosophy of Pythagoras.⁴

Let us now ‘look at’ the first few *triangular numbers*, here demonstrated as triangular collocations of dots:

For example: let $n = 6$, $t = 3$, and $a_1 = 4$. Then $\{a_k\}$ is:

$$a_1 = 4, \quad a_2 = 7 = 4 + 3, \quad a_3 = 10 = 7 + 3, \quad a_4 = 13 = 10 + 3, \quad a_5 = 16 = 13 + 3, \quad \text{and} \\ a_6 = 19 = 16 + 3. \text{ i.e. } \{a_k\} = \{4, 7, 10, 13, 16, 19\}.$$

Now starting instead with a sum total \mathcal{A}_n , let $n = 5$, $t = 1.8$, and $\mathcal{A}_n = 111$. Then:

$$a_1 = (2 \times 111 - 5 \times 4 \times 1.8) \div (2 \times 5) = 18.6.$$

$$\text{Therefore, } a_2 = 20.4 = 18.6 + 1.8, \quad a_3 = 22.2 = 20.4 + 1.8, \quad a_4 = 24 = 22.2 + 1.8, \quad \text{and} \\ a_5 = 25.8 = 24 + 1.8, \text{ so that } \{a_k\} = \{18.6, 20.4, 22.2, 24, 25.8\}.$$

For the sake of verification, we confirm that:

$$\mathcal{A}_5 = a_1 + a_2 + a_3 + a_4 + a_5 = 18.6 + 20.4 + 22.2 + 24 + 25.8 = 111 \text{ indeed.}$$

As a final illustration, given $n = 4$, $\mathcal{A}_n = 209$, and $a_1 = 5$, we now infer t :

$$t = (2 \times 209 - 2 \times 4 \times 5) \div (4 \times 3) = 31.5. \text{ So, } \{a_k\} \text{ is:}$$

$$a_1 = 5, \quad a_2 = 36.5, \quad a_3 = 68, \quad \text{and} \quad a_4 = 99.5: \{a_k\} = \{5, 36.5, 68, 99.5\}. \text{ As a check:}$$

$$\mathcal{A}_4 = a_1 + a_2 + a_3 + a_4 = 5 + 36.5 + 68 + 99.5 = 209, \text{ truly.}$$

Triangular Numbers and Durations

In the formulae for arithmetic progressions, if we put $a_1 = 1$ and $t = 1$, then we obtain the (vertex-centred) *triangular numbers*, $\{\mathcal{A}_k\}$, $1 \leq k \leq n$. Now:

$$a_1 = 1, \quad a_2 = 2 = 1 + 1, \quad a_3 = 3 = 1 + 2, \quad \dots, \quad a_k = k = 1 + k-1 \times 1, \quad \dots, \quad a_n = n.$$

i.e. $a_{k+1} = a_k + 1$ (for $1 \leq k \leq n-1$), and $\{a_k\} = \{1, 2, 3, \dots, k, \dots, n\}$, the set of integers from 1 to n .

So $\mathcal{A}_k = 1 + 2 + 3 + \dots + k = k \times k+1 \div 2$, giving:

$$\mathcal{A}_1 = 1, \quad \mathcal{A}_2 = 3, \quad \mathcal{A}_3 = 6, \quad \mathcal{A}_4 = 10, \quad \mathcal{A}_5 = 15, \quad \mathcal{A}_6 = 21, \quad \dots \text{ etc.}$$

$$\text{i.e. } \{\mathcal{A}_k\} = \{1, 3, 6, 10, 15, 21, \dots\}.$$

To convert such triangular numbers into '*triangular durations*', we simply multiply everything by some *chronos protos* d_1 , so that: $d_k = a_k \times d_1$ (wherein $1 \leq k \leq n$), and

therefore $s_n = \mathcal{A}_n \times d_1$.

Or, when one would rather work initially from a given total time-span s_n , we conclude that: $d_1 = (2 \times s_n) \div (n \times n+1)$, and generally: $d_k = (2 \times k \times s_n) \div (n \times n+1)$, for $1 \leq k \leq n$.

The earliest instance of ‘triangular durations’ with which I am acquainted comes from the introductory section of Olivier Messiaen’s **Regard de l’Onction terrible** – the eighteenth movement from his cycle of twenty solo piano pieces, **Vingt Regard sur l’Enfant-Jésus** (1944) – wherein a ‘triangular rhythm’ is set in canon against its retrograde, to activate parallel harmonies that flow in contrary motion inwards from the piano’s extreme registers.⁷ Perhaps, when one ponders the deeply Catholic theological tenor of this piano work, and its title, Messiaen’s impetus for composing his ‘triangular rhythmic canon’ here might have been to evoke (and extol) the Holy Trinity?⁸

Square Numbers and Durations

Within the formulae for arithmetic progressions, if we put $a_1 = 1$ with $t = 2$, then we obtain the (vertex-centred) *square numbers*, $\{\mathcal{A}_k\}$, $1 \leq k \leq n$. Hence:

$$a_1 = 1, a_2 = 3 = 1 + 2, a_3 = 5 = 1 + 4, \dots, a_k = 2k-1 = 1 + k-1 \times 2, \dots, a_n = 2n-1.$$

i.e. $a_{k+1} = a_k + 2$ (wherein $1 \leq k \leq n-1$), and $\{a_k\} = \{1, 3, 5, \dots, 2k-1, \dots, 2n-1\}$, the set of successive odd integers from 1 to $2n-1$.

Therefore, $\mathcal{A}_k = 1 + 3 + 5 + \dots + 2k-1 = k \times (1 + 2k-1) \div 2 = k^2$, yielding:

$$\mathcal{A}_1 = 1, \mathcal{A}_2 = 4, \mathcal{A}_3 = 9, \mathcal{A}_4 = 16, \mathcal{A}_5 = 25, \mathcal{A}_6 = 36, \dots \text{ etc.}$$

$$\text{i.e. } \{\mathcal{A}_k\} = \{1, 4, 9, 16, 25, 36, \dots\}.$$

In order to change these square numbers into ‘*square durations*’, one merely multiplies everything by some *chronos protos* d_1 , so that: $d_k = a_k \times d_1$ (for $1 \leq k \leq n$), and thus $s_n = \mathcal{A}_n \times d_1$.

Or, if one would prefer to compute originally from a given total time-span s_n , we deduce that: $d_1 = s_n \div n^2$, and generally: $d_k = (2k-1 \times s_n) \div n^2$, with $1 \leq k \leq n$.

Concerning the imagery of the square form – and of its correlative number ‘4’, as well as 4’s second power ‘16’ – the square is one of

the most common symbolic signs; it is a static, non-dynamic symbol, often seen in

relation and in contrast to the circle, a symbol of the earth in contrast to heaven ... or of the limited in contrast to the unlimited. It is also a symbol of the four cardinal directions [north, south, east, and west]. It is frequently used as a foundation of temples, altars, cities or as an architectonic unit, such as in the Romanesque style. In China, the cosmos and the earth were thought to be quadratic. The Pythagoreans saw the square as a symbol of the united workings of the four elements ['air', 'water', 'fire', and 'earth'] and thus of the powers of Aphrodite, Demeter, Hestia and Hera, the synthesis of whom was thought to be Rhea, mother of the gods. According to Plato, the square, next to the circle, embodies absolute beauty. In Islam, the square plays a role in various contexts; the hearts of normal people, for example, were thought to be square, because they were open to four possible sources of inspiration: the divine, the angelic, the human, and the devilish (the hearts of the prophets, on the other hand, are triangular, because they are no longer subject to the devil's attacks). In Christian art, the square is sometimes a symbol of the earth in contrast to heaven. Square haloes of people (then) still living thus indicate that the figure is still of this earth. C. G. Jung sees the square as a symbol of matter, of the flesh, and of earthly reality. [On the quadrature of the circle, it is the] unsolvable task of converting a given circle into a square of equal area by using only a ruler and compass. It is a symbol of the attempted [inter]penetration of the symbolic meaning[s] of the circle and the square.

[Four is the] basic number of the feminine, also regarded as a cosmic number and a number of harmony; it is based on the second power of 2, i.e., $2^2 = 2 \times 2 = 4$; with the 4 seasons, it is a manifestation of Mother Earth = 4; the number 2, with its maternal principle, thus expands to include the cosmos, which is bounded by 4 [NB: Albert Einstein saw our Universe, physically, as a four-dimensional space-time continuum]. As a symbolic number, 4 is closely related to the square and the circle. It is the number of the 4 cardinal directions and thus of the 4 winds, the 4 [alchemical] elements ..., the 4 humors, the 4 rivers of Eden, the 4 Evangelists, and the 4 stages of life (childhood, youth, maturity, old age).

The number 16 is a number symbolic of completeness and perfection and is probably associated with the four elements in their squared form, i.e., $4^2 = 4 \times 4 = 16$.⁹

General Formulae for Vertex-Centred Polygonal Numbers and Durations

We shall assume that the generative regular polygon has r sides, and so name this r -sided planar figure an ' r -gon'. So, in the process of calculating *vertex-centred figurate numbers* by aggregating dots into the shape of an r -gon, at every step one nests the r -gons so that they all possess *one vertex in common* – they are, therefore, *not* 'concentric' r -gons; moreover, each side of the k th (r -gonal) figure's perimeter will contain k dots ($k \geq 2$). How many dots overall, then, does the k th vertex-centred r -gonal number encompass? In our formulae for arithmetic progressions, if we let $a_1 = 1$ and $t = r-2$ (at the same time altering those formulae's subscripts sensibly in order to accommodate the new variable r), then we can elicit the *vertex-centred polygonal numbers*, $\{a_{r,k}\}$, $1 \leq k \leq n$. Thus:

$$a_{r,1} = 1; \quad a_{r,2} = 1 + r-2; \quad a_{r,3} = 1 + 2 \times r-2; \quad \dots \quad ; \quad a_{r,k} = 1 + k-1 \times r-2; \quad \dots \quad ; \\ a_{r,n} = 1 + n-1 \times r-2.$$

i.e. $a_{r,k+1} = a_{r,k} + r - 2$ (where $1 \leq k \leq n-1$), and:

$$\{a_{r,k}\} = \{1, 1 + r - 2, 1 + 2 \times r - 2, \dots, 1 + k - 1 \times r - 2, \dots, 1 + n - 1 \times r - 2\}.$$

Hence, $\mathcal{A}_{r,k} = k \times (2 + k - 1 \times r - 2) \div 2$, with $\mathcal{A}_{r,k+1} = \mathcal{A}_{r,k} + a_{r,k+1}$, i.e.:

$$\mathcal{A}_{r,1} = 1; \mathcal{A}_{r,2} = r; \mathcal{A}_{r,3} = 3 \times r - 1; \mathcal{A}_{r,4} = 2 \times 3r - 4; \mathcal{A}_{r,5} = 5 \times 2r - 3; \mathcal{A}_{r,6} = 3 \times 5r - 8; \dots \text{ etc.}$$

$$\text{i.e. } \{\mathcal{A}_{r,k}\} = \{1, r, 3 \times r - 1, 2 \times 3r - 4, 5 \times 2r - 3, 3 \times 5r - 8, \dots\}.$$

For instance, the sixth (vertex-centred) heptagonal number, $\mathcal{A}_{7,6}$, is 81.

To transform such polygonal numbers into '*polygonal durations*', we just multiply everything by some *chronos protos* d_1 , so that: $d_k = a_{r,k} \times d_1$ (for $1 \leq k \leq n$), and so $s_n = \mathcal{A}_{r,n} \times d_1$.

Or, whenever we wish to calculate vertex-centred polygonal durations starting from a given total time-span s_n , we compute that: $d_1 = 2 \times s_n \div (n \times (2 + n - 1 \times r - 2))$, and generally: $d_k = 2 \times (1 + k - 1 \times r - 2) \times s_n \div (n \times (2 + n - 1 \times r - 2))$, wherein $1 \leq k \leq n$.

General Formulae for Centred Polygonal Numbers and Durations

(Again, we will presume that the causative regular polygon is an r -gon.) To ascertain the values of *centred figurate numbers* by arraying dots in the shape of an r -gon, at each step the r -gons are nested concentrically: they all have a *common centre* – they are therefore *not* 'vertex-centred' r -gons – and each side of the k th (r -gonal) figure's perimeter consists of k dots (for $k \geq 2$). How many dots in total, then, does the k th centred r -gonal number comprise? In the formulae for arithmetic progressions, if we set $a_1 \equiv 1$ and $a_2 = r$, with $t = r$ whenever $k \geq 2$, then we are able to procure the *centred polygonal numbers*, $\{\mathcal{A}_{r,k}\}$, $1 \leq k \leq n$. Therefore:

$$a_{r,1} = 1; a_{r,2} = r; a_{r,3} = 2r; \dots; a_{r,k} = k - 1 \times r; \dots; a_{r,n} = n - 1 \times r.$$

i.e. $a_{r,1} \equiv 1$ and $a_{r,k+1} = a_{r,k} + r$ when $2 \leq k \leq n - 1$, so that in general:

$$\{a_{r,k}\} = \{1, r, 2r, \dots, k - 1 \times r, \dots, n - 1 \times r\}.$$

Thus, $\mathcal{A}_{r,k} = 1 + r \times k \times k - 1 \div 2$, whereby $\mathcal{A}_{r,k+1} = \mathcal{A}_{r,k} + a_{r,k+1}$, indicating that:

$$\mathcal{A}_{r,1} = 1, \mathcal{A}_{r,2} = r + 1, \mathcal{A}_{r,3} = 3r + 1, \mathcal{A}_{r,4} = 6r + 1, \mathcal{A}_{r,5} = 10r + 1, \mathcal{A}_{r,6} = 15r + 1; \dots \text{ etc.}$$

i.e. $\{A_{r,k}\} = \{1, r+1, 3r+1, 6r+1, 10r+1, 15r+1, \dots\}$.

For instance, the sixth centred heptagonal number, $A_{7,6}$, is 106.

To turn these centred polygonal numbers into ‘*centred polygonal durations*’, we multiply everything by some *chronos protos* d_1 as before, so that: $d_k = a_{r,k} \times d_1$ (for $1 \leq k \leq n$), and so $s_n = A_{r,n} \times d_1$.

Or, whenever one desires to evaluate centred polygonal durations instead by commencing with a given total time-span s_n , we see that: $d_1 = 2 \times s_n \div (2 + r \times n \times n - 1)$, and generally: $d_k = 2 \times k - 1 \times r \times s_n \div (2 + r \times n \times n - 1)$, for $2 \leq k \leq n$.¹⁰

Two Musical Examples from 153 Infinities

Although it is by no means obvious while taking a cursory glance at its time-space notation, the passage from p.9 (ca.14.5") to p.10 (ca.79.5") within **153 Infinities** projects an ‘acoustical mandala’ built from four intermeshed rhythmic layers of polygonal durations derived from figurate numbers: two of these layers consist of ‘triangular durations’, another is comprised of ‘square durations’ (whose d_k unfold retrogressively), whilst the fourth stratum embodies ‘centred pentagonal durations’ (here, the centred-pentagonal d_k have been permuted). However, the *chronos protoi* behind these four rhythmic lines all possess different lengths, having been adjusted proportionally so that all four total time-spans turn out to be identical; or, one might instead view this passage as an example of *multiple tempos* – i.e. four distinct (but arithmetically cognate) tempi ticking away simultaneously, whose pulses all commence together from this passage’s first attack, but only synchronize again at its last chord. Either way, the table below captures the situation:

Layer	Polygon Type	a_k (in order)	A_k	‘Tempo Ratios’
1	triangular	1 2 3 4 5 6 7 8 9 10 11	$A_{11} = 66$	$66:66 = 1:1$
2	square	17 15 13 11 9 7 5 3 1	$A_9 = 81$	$81:66 = 27:22$
3	centred pentagonal	30 25 10 15 1 5 20	$A_7 = 106$	$106:66 = 53:33$
4	triangular	1 2 3 4 5 6 7 8 9 10 11 12	$A_{12} = 78$	$78:66 = 13:11$

I have also attempted to ‘refract’ these four rhythmic strata somewhat through various registral, dynamic and articulatory strategies: the two sets of ‘triangular durations’ are matched to sonorities that fan out (in contrary motion) from the grand piano’s mid-range, with *crescendi* of dynamic levels; the other polygonal durations’ timbres, by contrast, are registrally variable, but likewise unfurl with *crescendi*. The growth-rate contours of these *crescendi*, however, are all shaped quite distinctively, so that attacks in close temporal

proximity to one another which issue from separate ‘polygonal duration-sequences’ are never resonated at the same dynamic level. Moreover, the ‘square’ and ‘pentagonal’ rhythmic layers are further clarified via the technical parameter of chord-tone articulations – the ‘pentagonal d_k ’ utilize leisurely *tenuto* grace-note groups, whereas the ‘square’-durations’ grace-note attacks must be rapidly yet lightly ‘bounced’, “As fast as possible!: a remote (and receding) tintinnabulation of chord-tones, somewhat obscure yet lyrical, like sanctus-bells”.¹¹

On pp.5–6 of **153 Infinities**, from ca.12.8" to ca.43.4", the grand piano’s attacks are distributed as “‘tolling bells’ (in arithmetic series)”¹² – in fact, they form a Tetractys set of ‘triangular durations’ whose d_k are proportioned 1:2:3:4:ln 10,¹³ with the ‘primary spans’ (notated as normal-sized noteheads, not as grace-notes) within the ln 10 time-field being partitioned off into the ratios 4:3:2. (For this schema, $d_1 \propto 62$ mm in my time-space notation, so that $\ln 10 \propto \approx 142.76$ mm.) My use here of logarithmically-related durations indeed pre-empts the ‘logarhythms’ within the six percussion parts, which ‘speak in tongues’ so dramatically towards the quietus of **153 Infinities**. Furthermore, the symmetric temporal construct embedded within this brief excerpt – featuring two short arithmetic progressions, {2:3:4}:{4:3:2 within ln 10} – is yet another instance of *diachronous proportional self-similarity* (in the ratio $9:\ln 10 \approx 9:2.302585093$), despite its internal numerics being palindromic.

1.2.11.2 DURATIONS THAT FORM A GEOMETRIC PROGRESSION

A *geometric progression* is an ordered sequence of quantities – $g_1, g_2, g_3, \dots, g_k, \dots, g_n$ – wherein the *ratio* of successive terms in the progression always remains constant: $g_{k+1} \div g_k = t$, for $1 \leq k \leq n-1$ and $t \neq 1$. Hence, the geometric progression $\{g_k\}$ is:

$$g_1, g_2 = g_1 \times t, g_3 = g_1 \times t^2, \dots, g_k = g_1 \times t^{k-1}, \dots, g_n = g_1 \times t^{n-1}.$$

$$\text{i.e. } g_{k+1} = g_k \times t \text{ (for } 1 \leq k \leq n-1\text{), and } \{g_k\} = \{g_1, g_1 \times t, g_1 \times t^2, \dots, g_1 \times t^{n-1}\}.$$

If we now write $\{g_k\}$'s *kth cumulative value* as $G_k = g_1 + g_2 + g_3 + \dots + g_k$ (in which $1 \leq k \leq n$), then $G_{k+1} = G_k + g_{k+1}$, and – in particular – $\{g_k\}$'s *sum total* G_n is:

$$G_n = g_1 + g_2 + g_3 + \dots + g_n = g_1 \times (1 + t + t^2 + t^3 + \dots + t^{n-1}) = g_1 \times (t^n - 1) \div (t - 1).$$

However, instead of beginning calculations with some particular value for g_1 , if we would rather deduce g_1 from a given quantity G_n , then:

$$g_1 = G_n \times (t - 1) \div (t^n - 1), \text{ and so: } g_k = G_n \times (t - 1) \times t^{k-1} \div (t^n - 1), \text{ where } 1 \leq k \leq n.$$

For example: let $n = 7$, $t = 1.5$, and $g_1 = 2$. Then $\{g_k\}$ is:

$$g_1 = 2, \quad g_2 = 3 = 2 \times 1.5, \quad g_3 = 4.5 = 3 \times 1.5, \quad g_4 = 6.75 = 4.5 \times 1.5, \quad g_5 = 10.125 = 6.75 \times 1.5, \quad g_6 = 15.1875 = 10.125 \times 1.5, \text{ and } g_7 = 22.78125 = 15.1875 \times 1.5.$$

$$\text{i.e. } \{g_k\} = \{2, 3, 4.5, 6.75, 10.125, 15.1875, 22.78125\}.$$

If instead we commence with a sum total G_n , then let $n = 5$, $t = 1.2$, and $G_n = 144$. Therefore:

$$g_1 = 144 \times (1.2 - 1) \div ((1.2)^5 - 1) \approx 19.35067727.$$

$$\text{Thus, } g_2 = g_1 \times 1.2 \approx 23.22081273, \quad g_3 = g_2 \times 1.2 \approx 27.86497527, \quad g_4 = g_3 \times 1.2 \approx 33.43797033, \text{ and } g_5 = g_4 \times 1.2 \approx 40.12556439, \text{ so that:}$$

$$\{g_k\} = \{19.35067727, 23.22081273, 27.86497527, 33.43797033, 40.12556439\}.$$

For the sake of confirmation, we now verify that:

$$G_5 = g_1 + g_2 + g_3 + g_4 + g_5 \approx 19.35067727 + 23.22081273 + 27.86497527 + 33.43797033 + 40.12556439 = 144 \text{ indeed.}$$

To convert such numerical geometric progressions into an homologous sequence of ‘*geometric durations*’, one straightforwardly multiplies everything by some *chronos protos* d_1 , so that: $d_k = g_k \times d_1$ (for $1 \leq k \leq n$), and thus $s_n = g_n \times d_1$.

Likewise, given a total time-span s_n , we now conclude that: $d_1 = s_n \times (t - 1) \div (t^n - 1)$, and more generally: $d_k = s_n \times (t - 1) \times t^{k-1} \div (t^n - 1)$, when $1 \leq k \leq n$.

Whenever a *chronos protos* is proliferated into a geometric progression of durations through multiplication by the same numerical constant, *proportional self-similarity* becomes an automatic legacy – since successive durations within the progression will always be harnessed together by a common ratio. When such durations present themselves ‘through time’ (one after another), the self-similarity is *diachronous*; but when they have been ‘nested’ across neighbouring architectonic levels instead, we speak, rather, of *synchronous* proportional self-similarity. It is perhaps surprising that the latter approach, evincing ‘geometric synchronicity’, is venerable. Indeed, Jonathan Kramer observes in relation to Western music from the Classical period, that

... the economy of the geometric series 1, 2, 4, 8, 16, in traditional [Classical] music often determines hypermetric lengths on successive levels, with deviations (contractions, extensions, overlaps) [being] provided by the arithmetic series 1, 2, 3, 4, 5,¹

From the rather more recent past, Kramer’s exhaustive proportional analysis of Igor Stravinsky’s ballet **Agon** (1954–1957) convincingly demonstrates how a geometric progression of durations with a prevailing ratio of $t \approx 1.19 \approx \sqrt[4]{2} = 2^{0.25}$ suffuses this piece – synchronously *and* diachronously – throughout several architectonic planes, as a kind of unifying temporal blueprint or causative force-field:²

The most pervasive and elegant proportioning I have found in Stravinsky’s music is in **Agon**. This highly discontinuous work has puzzled commentators by its disparity of materials yet unmistakable unity. Part of the reason for its unity is the incredible sense of balance Stravinsky creates by utilizing one ratio to determine virtually all the important durations, from the level of the submoment (as brief as 14 seconds) to the entire 18-minute composition. The sections in **Agon** are delineated by a great variety of means, including but not limited to harmonic stasis. Even the compositional methods (serial vs. neotonal) vary. Yet **Agon** magically coheres. The pervasiveness of one proportional ratio is the key to the unity that is not readily apparent on the work’s surface. ...³

In **Agon** Stravinsky uses a ... complex ratio, which is not expressible by small whole numbers: 1.19:1. ... Almost all of the approximations [of time-spans] in **Agon** are within 2.7% accuracy [relative to some ideal geometric progression based upon the ratio 1.19:1] ... Such close approximations are surely well within the limits of perception. It is remarkable that **Agon** utilizes its proportional ratio as consistently and on as many structural levels as it does. It is amazing that it does so to such a high degree of precision. Stravinsky’s sensitivity to formal proportions is impressive.⁴

The basic ratio [in the proportional system of **Agon**] is 1.19:1. This ratio is not as strange as it may at first seem, as it is really $\sqrt[4]{2}:1$ [i.e. the interval ratio of an equal-tempered minor 3rd]. ... The musical significance of $\sqrt[4]{2}:1$ is that the series doubles every fourth term (for example, the [geometric] subseries 40.2, 80.4, 160.8, 321.6, 643.2 is in the ratio 2:1). Thus sections twice as long as other sections are often encountered in **Agon**. The composer is therefore able to utilize a sophisticated series that also provides readily perceivable doubled durations. ... Comparison of [tabular data] shows how very close to the $\sqrt[4]{2}:1$ series the sectional durations are [most deviations being at most 2%]; only one approximation is poor [with a deviation of 6.7%]. Equally amazing is the range of the series. Durations from 40.7 to 1109.5 seconds [i.e. the total span of the piece] approximate terms of the reference series. ... Careful study [of the tabular data] should indicate the impressive pervasiveness of the basic ratio. Stravinsky's choice of this particular ratio proved fruitful, as it allows for two long chains of proportionally related durations and since it includes several 2:1 ratios. The closeness of approximation is strong evidence that these [two geometric progressions] do indeed operate structurally. The participation of [almost all structural units] ... in one of the[se] two series testifies to the thoroughness of Stravinsky's system. The fact that both series are projected onto high levels, thus determining durations up to that of the entire composition, is further proof of the significance of this construction. ... **Agon**, Stravinsky's most mosaic-like, most discontinuous, seemingly least consistent work is in fact unified by a tight system of [geometric] durational proportions. What results from his great sensitivity to sectional lengths is a beautifully balanced composition. The composer's achievement is extraordinary; it bespeaks [of] both an incredibly well developed intuition and [of] a deep understanding of the implications of discontinuity.⁵

[The ubiquity of the $\sqrt[4]{2}:1$ geometric-progression ratio as a durational determinant herein goes] a long way toward explaining the mysterious sense of unity in **Agon**, despite the disparity in materials and compositional procedures and despite the extreme discontinuity between [(sub)sections]. ... [But Stravinsky] went beyond simply the creation of discontinuities and static forms. He found a means of convincing the ear of the functional equivalence of sections of different lengths. Therein lies his great originality. He invented a compositional technique, apparently intuitively, that allowed him to create structures that cohere despite vastly different durations and extreme discontinuities. This [geometric proportional] technique allowed him to compose pieces that are beautiful statements of the aesthetic of nonlinear time.⁶

As stepwise increasingly accurate *approximations* of a geometric progression whose constant multiplier is the Golden Section ratio $\Phi = ((\sqrt{5} + 1) \div 2) \approx 1.618034$, numerous composers (from the late Middle Ages through to the present day)⁷ have modelled durations in their pieces after the Fibonacci series –

$$\{F_k\} = \{1, 1, 2, 3, 5, 8, 13, 21, 34, 55, 89, 144, \dots\}$$

– and after its less well known cognate, the Lucas series –

$$\{L_k\} = \{1, 3, 4, 7, 11, 18, 29, 47, 76, 123, 199, 322, \dots\}.$$
⁸

Indeed, “[the] Fibonacci series provides composers with the means to approximate golden-mean proportions [in geometric progressions] closely while using the integer values

convenient for traditional meters and [mensural] note durations".⁹

Both of these number-series can be characterized by the additive recursion formula $a_{k+2} = a_{k+1} + a_k$: with $a_1 = a_2 = 1$ we obtain $\{F_k\}$; with $a_1 = 1$ but $a_2 = 3$ instead, we extract $\{L_k\}$. Now as k grows ever larger, the ratios of successive terms $a_{k+1}:a_k$ – and hence of successive Fibonacci numbers $F_{k+1}:F_k$ and of successive Lucas numbers $L_{k+1}:L_k$ – become an increasingly superior approximation of (and, when $k \rightarrow \infty$, eventually converges upon) Φ . So the bigger that k becomes, the more our Fibonacci series $\{F_k\}$ and Lucas series $\{L_k\}$ mimics a proper geometric progression whose common ratio is Φ .¹⁰

The Golden Section ratio Φ , and the Fibonacci numbers $\{F_k\}$ in particular, are indeed semiologically, culturally, scientifically, and naturally fecund:

It should not be surprising that golden-mean proportions and Fibonacci numbers appear in music. Numerous mathematical properties of the Fibonacci series have appealed to artists and scientists for centuries, and golden-section proportions are frequently found in nature, human or otherwise. There is experimental evidence, for example, that the golden mean determines the ratio of people's positive to negative value judgments ... There is also experimental evidence that rectangles (cards, mirrors, pictures, etc.) proportioned according to the golden section (ratio of the longer to the shorter side is 1.62) appeal to our sense of symmetry. The golden proportions in Greek vases and the poetry of Vergil were apparently created by Fibonacci numbers, as were some of the proportions in Minoan, Greek, and Gothic architecture. Fibonacci numbers were used in mosaic designs in several ancient countries. The Fibonacci series is found in patterns of shell growth and in phyllotaxis, or leaf and petal arrangement. Various types of flowers, for example, tend to have Fibonacci numbers of petals; and, in trees with spiral arrangements of leaves or branches, the Fibonacci series determines the number of rotations before a leaf or branch is found directly above a given one. Also, there tends to be a Fibonacci number of leaves or branches in such spirals. The Fibonacci series influences the number of spirals of eyes (fruitlets) in pineapples and pine cones. It determines the number of ancestors for each generation of bees. Fibonacci numbers are used in certain electrical networks, and they are approximated in the structures of atomic and subatomic particles. The ratios of the distances of the satellites of Jupiter, Saturn, and Uranus from their parent planets approximate 1.62, as do (in a weaker approximation) the distances of the planets (including the asteroid belt) from [our] sun. Fibonacci numbers have been used in the branch of cancer research that attempts to construct a mathematical model for the movement of malignant cells, and they have been used in water pollution control to determine where best to place sewage treatment plants for cities on the same river. Fibonacci numbers relate to the numbers of years in cycles between peaks and peaks, peaks and lows, and lows and lows of the stock market. It has even been suggested that Fibonacci numbers determine the lengths of cycles of grasshopper abundance, automobile factory sales, the ratio of male to female conceptions, advertising effectiveness, sunspots, tree ring size, rainfall in India, Nile floods, financial panics, and furniture production!¹¹

Within **153 Infinities**, the durations (in seconds) of the percussionists' bars – 1", 5", 8", 13", and 8" (at the beginnings of which they synchronize attacks) – all belong to the

Fibonacci series $\{F_k\}$, so that some of my relative bar-lengths here display an *inexact* diachronous proportional self-similarity: $8:5 \approx 13:8 \approx \Phi$. On the other hand, the percussionists' rhythmic material itself – whenever its durations are meant to be isomorphic to arithmetic, geometric, or logarithmic progressions – is, however, always mathematically *exact*.¹² What ensues, then, is a polyphonic labyrinth whereby such durational progressions all evolve quite independently of one another, from *chronos protoi* of various lengths, and according to different values for t in the relevant formulae.

Within the percussion music from **153 Infinities**, ten out of its twenty-eight mathematically conceived rhythms do indeed manifest geometric progressions. However, I deliberately restricted their menu of common multipliers to just four well-known constants – $e \approx 2.71828182845$; $\pi \approx 3.1415926536$; $\sqrt{2} \approx 1.4142135623$; and $\sqrt{3} \approx 1.7320508075$ – whose values (being fundamental to geometry) are all-pervasive throughout the physical world. Numerically, these four constants are each *irrational* as well (i.e. they are inexpressible as fractions [ratios of whole numbers]); the first two are even *transcendental*.¹³

The table below, in which every one of the g_k is expressed *in millimetres* accurate to two decimal places (these g_k being convertible into d_k via the time-space equation 1 second = 40 mm), discloses all of the essential data behind these ten ratio-based rhythmic designs:

Player	Instruments	Location	Sum Total *	t	g_k (in order), $k \geq 1$
2	triangle windchime	ca.12.6"–ca.32.5"	793.50 mm	e	213.41 mm, 580.09 mm †
2	almglocken 1	ca.21.1"–ca.26.95"	233.00 mm	$(\sqrt{3})^{-1}$	147.72 mm, 85.28 mm
4	triangle windchime	ca.3.7"–ca.11.0"	289.91 mm	π	70.00 mm, 219.91 mm
4	triangle windchime	ca.15.5"–ca.32.5"	678.95 mm	$\sqrt{2}$	60.39 mm, 85.41 mm, 120.78 mm, 170.81 mm, 241.56 mm †
4	autocoil	14"–ca.34.2"	806.50 mm	π	1.80 mm, ‡ 5.65 mm, ‡ 17.75 mm, 55.76 mm, 175.18 mm, 550.36 mm
4	brass bell windchime	ca.23.9"–ca.30.9"	279.72 mm	$\sqrt{3}$	25.60 mm, 44.33 mm, 76.79 mm, 133.00 mm
5	bass drum	ca.30.5"–ca.32.2"	63.00 mm	$(\sqrt{2})^{-1}$	20.24 mm, 14.31 mm, 10.12 mm, 7.16 mm, 5.06 mm, 3.58 mm, 2.53 mm
6	brake drum	ca.15.7"–ca.21.8"	242.60 mm	$(\sqrt{3})^{-1}$	153.80 mm, 88.80 mm
6	triangle windchime	ca.9.2"–ca.16.3"	284.52 mm	e^{-1}	208.00 mm, 76.52 mm
6	tam-tam	14"–ca.21.5"	298.50 mm	π^{-1}	226.43 mm, 72.07 mm

* NB: sum-total values *in italics* were decided upon first; and then their attack-endpoints were painstakingly situated within the musical discourse, prior to (or in conjunction with) calculating the internal g_k .

† The last attack here was established first of all; these (cued) attacks are both meant to coincide.

‡ Due to their brevity, the corresponding durations d_k have both been notated as grace-notes.

None of these ten rhythms' durations have been subjected to permutation or to any other process whatsoever – although half of them do pan out 'in reverse' as it were, accelerating as their time-values continue to shrink geometrically. (Another perspective on such 'quickening' is that, rather than being a multiplier within the formulae, t has instead become a constant *divisor* for these rhythms; so, this operation is mathematically equivalent to multiplying g_1 again and again by the constant's reciprocal, t^{-1} – as can be readily observed in this table.)

1.2.11.3 'LOGARHYTHMS': SETS OF LOGARITHMICALLY RELATED DURATIONS

Within **A World of Becoming**, I define a *logarithmic progression* to be an ordered sequence of values $l_1, l_2, l_3, \dots, l_k, \dots, l_n$ which obeys the elementary rule $l_k = t \times \log k+1$, for $1 \leq k \leq n$.¹ Therefore, the logarithmic progression $\{l_k\}$ is:

$$l_1 = t \times \log 2, \quad l_2 = t \times \log 3, \quad l_3 = t \times \log 4, \quad \dots, \quad l_k = t \times \log k+1, \quad \dots, \quad l_n = t \times \log n+1.$$

$$\text{i.e. } \{l_k\} = \{t \times \log 2, t \times \log 3, t \times \log 4, \dots, t \times \log k+1, \dots, t \times \log n+1\}.$$

If we now write $\{l_k\}$'s *kth cumulative value* as $\mathcal{L}_k = l_1 + l_2 + l_3 + \dots + l_k$ (whereby $1 \leq k \leq n$), then $\mathcal{L}_{k+1} = \mathcal{L}_k + l_{k+1}$, and, in particular, $\{l_k\}$'s *sum total* \mathcal{L}_n is:

$$\mathcal{L}_n = l_1 + l_2 + l_3 + \dots + l_n = t \times (\log 2 + \log 3 + \log 4 + \dots + \log n+1) = t \times \log (n+1)! \text{ where } (n+1)! = n+1 \times n \times n-1 \times \dots \times 3 \times 2 \times 1.^2 \text{ (By definition, } t = \mathcal{L}_n \div \log (n+1)! \text{).}$$

But if we would prefer to calculate l_1 from a given value for \mathcal{L}_n , then:

$$l_1 = \mathcal{L}_n \times \log 2 \div \log (n+1)!, \text{ and more generally: } l_k = \mathcal{L}_n \times \log k+1 \div \log (n+1)!, \text{ where } 1 \leq k \leq n.$$

For instance: let $n = 10$ and $t = 1.78$ – for which we shall use (both here, and henceforth) the 'natural logarithm' function \ln .³ Then – using figures accurate to nine decimal places – $\{l_k\}$ is:

$$\begin{aligned} l_1 &= 1.78 \times \ln 2 \approx 1.233801981, & l_2 &= 1.78 \times \ln 3 \approx 1.955529874, & l_3 &= 1.78 \times \ln 4 \approx 2.467603963, \\ l_4 &= 1.78 \times \ln 5 \approx 2.864799484, & l_5 &= 1.78 \times \ln 6 \approx 3.189331855, \\ l_6 &= 1.78 \times \ln 7 \approx 3.463720065, & l_7 &= 1.78 \times \ln 8 \approx 3.701405944, & l_8 &= 1.78 \times \ln 9 \approx 3.911059748, \\ l_9 &= 1.78 \times \ln 10 \approx 4.098601466, \text{ and } l_{10} &= 1.78 \times \ln 11 \approx 4.268253585. \end{aligned}$$

$$\text{i.e. } \{l_k\} = \{1.233801981, 1.955529874, 2.467603963, 2.864799484, 3.189331855, 3.463720065, 3.701405944, 3.911059748, 4.098601466, 4.268253585\}.$$

But if, rather than beginning with a specific quantity for l_1 , we wish instead to evaluate l_1 from a given sum total \mathcal{L}_n , then let $n = 5$ and $\mathcal{L}_n = 236.8$ (in which case $t = 236.8 \div \ln 6! = 236.8 \div \ln 720 \approx 35.99193774$). So:

$$l_1 = 236.8 \times \ln 2 \div \ln 6! = 236.8 \times \ln 2 \div \ln 720 = t \times \ln 2 \approx 24.94771017.$$

Thus, $l_2 \approx 39.54118509$, $l_3 \approx 49.89542033$, $l_4 \approx 57.92678914$, and $l_5 \approx 64.48889526$, so that:

$$\{l_k\} = \{24.94771017, 39.54118509, 49.89542033, 57.92678914, 64.48889526\}.$$

And indeed:

$$\mathcal{L}_5 = l_1 + l_2 + l_3 + l_4 + l_5 \approx 24.94771017 + 39.54118509 + 49.89542033 + 57.92678914 + 64.48889526 = 236.8.$$

To transform such numerical logarithmic progressions into an analogous sequence of ‘*logarithmic durations*’ (or ‘*logarhythms*’), one just multiplies everything by a *chronos protos* d_1 , so that: $d_k = l_k \times d_1$ (where $1 \leq k \leq n$), and hence $s_n = \mathcal{L}_n \times d_1$.

As before, given a total time-span s_n , we can deduce that: $d_1 = s_n \times \log 2 \div \log (n+1)!$, and in general: $d_k = s_n \times \log k+1 \div \log (n+1)!$, when $1 \leq k \leq n$.

The algebraic structure of a set of durations in logarithmic progression is a direct consequence of the way in which each positive integer can be decomposed uniquely into a product of prime factors. Within the following table, the letters A, B, C, (and so on) signify the logarithm of p , where p is some prime number: these values are mathematically independent of one another, and so constitute the basic irreducible elements from which this table is built up. We are then able to discern sub-sequences which correlate to ‘triangular durations’ – A, 2A, 3A, ... ; B, 2B, 3B, ... ; C, 2C, 3C, ... ; ... (so that A, B, C, ... in effect define autonomous *chronos protoi*) – but also the various additive ‘linear combinations’ of A, B, and C, etc. (such as A+B, B+2C, A+2B+3D, C+2D+4E+F, and so forth) therein:

Logarithmic Values	Logarithmic Values	Logarithmic Values	Logarithmic Values
$\log 2 = A$	$\log 11 = E$	$\log 20 = 2A+C$	$\log 29 = J$
$\log 3 = B$	$\log 12 = 2A+B$	$\log 21 = B+D$	$\log 30 = A+B+C$
$\log 4 = 2A$	$\log 13 = F$	$\log 22 = A+E$	$\log 31 = K$
$\log 5 = C$	$\log 14 = A+D$	$\log 23 = I$	$\log 32 = 5A$
$\log 6 = A+B$	$\log 15 = B+C$	$\log 24 = 3A+B$	$\log 33 = B+E$
$\log 7 = D$	$\log 16 = 4A$	$\log 25 = 2C$	$\log 34 = A+G$
$\log 8 = 3A$	$\log 17 = G$	$\log 26 = A+F$	$\log 35 = C+D$
$\log 9 = 2B$	$\log 18 = A+2B$	$\log 27 = 3B$	$\log 36 = 2A+2B$
$\log 10 = A+C$	$\log 19 = H$	$\log 28 = 2A+D$	$\log 37 = L$
			etc.

Nine of the twenty-eight mathematically contrived rhythms within the percussionists’ music from **153 Infinities** are in fact ‘logarhythms’. The table below, wherein every one of the l_k is expressed *in millimetres* accurate to two decimal places (each l_k being

interchangeable with its logarithmic-durational mate d_k by way of the time-space equation 1 second = 40 mm), imparts all of the necessary data behind these nine ‘logarhythmic’ schemes:

Player	Instruments	Location	Sum Total *	l_k (in order), $k \geq 1$
1	brake drum	ca.14.6"–ca.23.2"	345.20 mm	49.98 mm, 79.21 mm, 99.96 mm, 116.05 mm
2	almglocken 2, 3 & 5	ca.18.45"–ca.24.9"	255.50 mm	85.89 mm, 73.98 mm, 58.63 mm, 36.99 mm †
2	Chinese cymbal	ca.20.7"–ca.26.8"	241.00 mm	105.13 mm, 83.31 mm, 52.56 mm †
4	autocoil	ca.1.7"–ca.9.7"	316.36 mm	138.00 mm, 109.36 mm, 69.00 mm †
4	Chinese bell tree	ca.8.0"–ca.23.4"	616.64 mm	89.28 mm, 141.50 mm, 178.56 mm, 207.30 mm ‡
4	brass tube windchime(s)	ca.16.9"–ca.34.6"	705.01 mm	74.28 mm, 117.72 mm, 148.55 mm, 172.46 mm, 192.00 mm ‡
6	brake drum	6"–ca.13.8"	308.50 mm	70.42 mm, 64.84 mm, 58.24 mm, 50.17 mm, 39.76 mm, 25.08 mm †
6	autocoil	ca.2.9"–ca.12.5"	385.00 mm	55.74 mm, 88.35 mm, 111.48 mm, 129.43 mm
6	Javanese gongs 1 & 2	ca.17.1"–ca.21.9"	192.50 mm	43.94 mm, 40.46 mm, 36.34 mm, 31.30 mm, 24.81 mm, 15.65 mm †

* NB: sum-total values *in italics* were decided upon first; and then their attack-endpoints were carefully positioned within the musical flow, prior to (or in conjunction with) computing the internal l_k .

† These ‘logarhythms’ are played *in reverse order* ($d_n, d_{n-1}, \dots, d_3, d_2, d_1$), accelerating as their d_k diminish logarithmically.

‡ Here, the final durations (i.e. d_n) were settled upon and then situated first of all. (Notice that the last [cued] attack of percussionist 4’s brass tube windchime[s] is intended to synchronize with that of percussionist 2’s brass tube windchime[s].)

Dimensiones Paradisi “embraces 37 sections: A, B, C, D, E, F, E', D', C', B', A', G, and H; and implanted amongst these 13 lettered sections are 24 proportionally interrelated ‘interjections’ α_1 to α_8 , β_1 to β_8 , and γ_1 to γ_8 ”.⁴ The time-spans of the twenty-four “proportionally interrelated ‘interjections’” are a by-product of the geometries that lie behind this composition’s organizational ‘mandala’; indeed, several of these Greek-lettered ‘interjections’ (especially some of the longer ones) are themselves internally partitioned in conformity with the same geometries’ proportions – thereby embodying architectonic self-similarity across two adjacent structural tiers. Yet for almost all α -, β - and γ -sections, either a ‘logarhythm’ fills up the entire section, or the principal subsection – a residuum of the aforesaid subdividing process, it encompasses the section-type’s characteristic musical material – will then be further segmented into logarithmically interconnected durations.⁵ Moreover, apart from sections β_6 and β_7 , the logarhythms’ constituent durations have been *permuted* (albeit unsystematically).⁶

Throughout **Dimensiones Paradisi**, γ -sections are typified by multihued runs of microtones in non-scalic order; its β -sections by (multiple) tremoli that sometimes abut air-

noises, whistle tones, and silences. The α -sections are more heterogeneous: the longest two flaunt sequences of beautiful multiple tremolos whose trilling-actions call for the D and D# trill-keys, while the rest summon up various multiphonics, quietudes, random whistle tones, and volatile air-noises. Let us now tabulate the 'logarithms' within three of **Dimensiones Paradisi's** 'interjectory sections' – one from each class:⁷

Dimensiones Paradisi, section γ_2 (pp.9–10)

γ_2 time-span: $11.21240815'' = s_{14}$; $n = 14$. $t = s_{14} \div \log 15!$.

NB: this section is dilated by the pitch $F\sharp 4$, whose duration falls outside my time-proportional 'logarithmic' construct. Moreover, most of the logarithmic durations herein are further broken up and variegated by sundry timbral, textural, intonational, or articulatory colorations of their microtones.

Sonorities (in order)	Microtonal Pitch(es), etc.	Durations (in seconds)
1	$E\sharp 4$ fluttermongued	$0.998656459'' \approx t \times \log 12$
2	$G\flat 4$	$0.278568174'' \approx t \times \log 2$
3	$\{G\flat 4, D\flat 5\}$ multiphonic, $D\flat 5$ harmonics, $D\flat 5$ fluttermongued	$1.088335381'' \approx t \times \log 15$
4	$C\sharp 5$	$0.441520110'' \approx t \times \log 3$
5	$C\sharp 5$ fluttermongued, tied to $C\sharp 5$ with key-vibrato	$1.060607910'' \approx t \times \log 14$
6	$F\sharp 4$ and its re-articulations	$0.925383444'' \approx t \times \log 10$
7	$F\sharp 4$	$0.782039735'' \approx t \times \log 7$
8	$F\sharp 4$; $\{F\sharp 4, D\flat 5\}$ multiphonic, tied to $F\sharp 4$	$0.720088284'' \approx t \times \log 6$
9	$E\sharp 4$ fluttermongued, tied to a normally-sustained $E\sharp 4$	$0.883040220'' \approx t \times \log 9$
10	$F\sharp 4$ and its re-articulations	$0.963687550'' \approx t \times \log 11$
11	$F\sharp 4$ fluttermongued	$0.646815270'' \approx t \times \log 5$
12	$G\flat 4$	$0.835704523'' \approx t \times \log 8$
13	$E\sharp 4$	$0.557136348'' \approx t \times \log 4$
14	$F\sharp 4$	$ca.0.26''$ (not logarithmic)
15	$D\flat 5$ with tongue-tremolo, and its re-articulation	$1.030824737'' \approx t \times \log 13$

Dimensiones Paradisi, section β_4 (p.4)

β_4 time-span: $10.20343798'' = s_8$; $n = 8$. $t = s_8 \div \log 9!$.

NB: this section is slightly elongated by a grace-note harmonic (pitched at $G\flat 4$) whose duration is independent of, but augments, the proportional chronomorphology.

Sonorities (in order)	Tremolo Pitches	Durations (in seconds)
1	$C\sharp 4$ ($B\sharp 3$)	$1.751253463'' \approx t \times \log 9$
2	$C\sharp 3$ ($A\sharp 3$)	$1.428085689'' \approx t \times \log 6$
3	$A\sharp 3$ ($D\flat 3$)	$1.104917916'' \approx t \times \log 4$
4	$A\sharp 3$ ($D\flat 3$)	$1.282769975'' \approx t \times \log 5$
5	$F\sharp 3$ ($A\sharp 3$)	$0.552458957'' \approx t \times \log 2$
6	$A\sharp 3$ ($E\sharp 3$)	$0.875626731'' \approx t \times \log 3$
7	$F\sharp 3$ ($A\sharp 3$)	$1.550948374'' \approx t \times \log 7$
8	$G\flat 4$ ($E\sharp 4$)	$1.657376873'' \approx t \times \log 8$

Dimensiones Paradisi, section α_1 (pp.13–14)

α_1 time-span: 36.00000000"; $s_8 = 36" \times 0.418130546 \approx 15.05269966"$; $n = 8$. $t = s_8 \div \log 9!$.

Sonorities (in order)	Trill Pitches	Durations (in seconds)
1	F # 3 (C \sharp 4, C \sharp 4, D \sharp 4)	2.445057866" $\approx t \times \log 8$
2	G # 3 (D \flat 4, D \flat 4, D \sharp 4)	2.288048412" $\approx t \times \log 7$
3	G \flat 3 (C \sharp 4, C # 4, D \sharp 4)	2.106794299" $\approx t \times \log 6$
4	A \flat 3 (C # 4, D \flat 4, E \flat 4)	1.892416184" $\approx t \times \log 5$
5	C # 4 (D \flat 4, E \flat 4, E \flat 4)	1.630038577" $\approx t \times \log 4$
6	B \flat 3 (D \flat 4, D \flat 4, E \flat 4)	1.291775010" $\approx t \times \log 3$
7	B \flat 3 (D \flat 4, D \flat 4, E \flat 4)	0.815019288" $\approx t \times \log 2$
8	C \flat 4 (D \flat 4, E \flat 4, E \flat 4)	2.583550020" $\approx t \times \log 9$

Before finally bidding adieu to ‘logarhythms’, one should understand that a logarithmic progression $\{l_k\}$ need not make use of every available l_k for $k \leq n$: rather, if there are to be n durations (as usual) therein, then one might formulate $\{l_k\}$ with $m \leq k \leq n+m-1$ for some m where $m \geq 2$. Within this scenario, we now glean:

$$\mathcal{L}_n = l_m + l_{m+1} + l_{m+2} + \dots + l_{n+m-1}, \text{ and so: } t = \mathcal{L}_n \div (\log (n+m)! - \log m!).$$

As before, $l_k = t \times \log k+1$, but with $m \leq k \leq n+m-1$.

Such a stratagem indeed becomes desirable whenever, in a full logarithmic progression, at least d_1 would be too brief either to perform or to notate properly (except perhaps as a grace-note). Setting an appropriate $m \geq 2$ within the above equations bypasses these impracticabilities, and renders a progression which is certainly no less logarithmic in nature – although the lattice of ‘triangular’ and other additive relationships between its resultant durations might deteriorate incrementally as one jettisons more and more of its primary building-blocks l_{p-1} , the products of $\log p$, where p is a small prime number ($p = 2, 3, 5, 7, 11, \dots$).

For example, within section γ_3 from **Dimensiones Paradisi** (p.11), its twenty logarithmically affiliated durations have all been proportioned (in order of growing magnitude) $\log 4 : \log 5 : \dots : \log 22 : \log 23$; i.e. $m = 3$. Here, within an overall time-span for γ_3 of $8.806204773" = s_{20}$, $d_1 \approx 0.245066999"$ (whereas if I had chosen to let $m = 1$ as usual, then d_1 would have lasted just a little over $0.1345"$ – rather too ephemeral for my taste, in this context).

1.2.12 GENERALIZED MATHEMATICAL FORMULAE FOR TEMPO-GLISSANDI

A *tempo-glissando* incorporates *accelerandi* or *rallentandi* (often over lengthy time-spans, across numerous beats) in a continuous, unbroken fashion – so that there are no sudden leaps anywhere from one tempo to another. My fascination with tempo-glissandi dates back to the early 1980s, when a former composition teacher of mine at the University of Sydney, Ian Fredericks, was attempting to mould ‘natural’-sounding long-range tempo-glissandi within a sequencing program upon a Yamaha CX5M music computer, by adopting the formulae for projectile motion under the influence of Earth’s force of gravity. With this same goal in mind (to achieve ‘naturalness’ and subtlety in the slow but relentless evolutions of tempi), I subsequently investigated other classes of mathematical equations with a view to basing tempo-glissandi upon them, employing one such formula within my **Echoes/Fantasies** (1984) for bass clarinet and percussion. (However, since composing **Echoes/Fantasies**, I have learnt that tempo-glissandi can be efficacious in other ways too.) So, within **A World of Becoming**, **Arcturus Timespace** and **Cycles of Vega** both feature tempo-glissandi which are guided by mathematical formulae.¹

How, then, does one notate a tempo-glissando? It is really a very simple matter of providing metronomic values within the score at regular intervals (at least once per bar, if possible) – even when a tempo-glissando’s regulating equation delivers incommensurable quantities:

Truly irrational *tempo* relationships are most frequently encountered in constant slow accelerations, where, if metronomic indications are given, close rational approximations to the intended irrational relationships are generally notated.²

Within my own compositions in **A World of Becoming**, tempo-values have been rounded up or down (whenever necessary) to the nearest whole number in almost all cases.³

The repetitive cyclical structures of compositions like **Arcturus Timespace** and **Cycles of Vega** tend to promote antiteleology, not goal-directedness. By their intrinsic nature, no propulsion towards a point of final repose is implied; rather, musical material (and any sense of time-flow) is proceeded through unceasingly, ‘in circles’. Extended tempo-glissandi can therefore be a valuable tool – and so become an authentic compositional dimension – if one wishes to superimpose tensional trajectories or goal-direction upon a piece’s cyclic morphology.⁴ But because of their expansive ranges, straddling many beats, tempo-glissandi within both of these works exert an extraordinarily subtle (perhaps even a subliminal) yet ineluctable force therein: their initial increase or decrease of tempi may be

virtually imperceptible.

Beyond the acts of composing and notating tempo-glissandi, there remains the important question of sculpting their contours live, with fidelity, as sonic phenomena in concert. Within the Performance Notes from **Cycles of Vega**, I have articulated what has, in practice, proved to be quite an effective regimen for dealing with this performative problem:

Cycles of Vega embraces extremely subtle, long-range *accelerandi* and *decelerandi* (bars 12–36; bars 86–178; and bars 180–214), the contours of which are defined by approximate tempo-indications every bar or so. In order that performers attain the required shapes of these tempo-contours fairly accurately, they are advised to repeatedly ‘count through’ the piece with an *electronic metronome*, turning the device’s dial correspondingly. This practice activity will greatly assist projecting, in concert, the right ‘feel’ of tempo-evolution. Of course, a certain degree of flexibility is permissible, provided that the general contours of tempi are preserved overall. Additionally, approximate durations (in minutes and seconds) of subsections of **Cycles of Vega** have been supplied, both singly and cumulatively, as an aid to executants in this respect.⁵

For the mathematical formulae for tempo-glissandi given below, almost all of which compute a shift of tempo in relation to the number of beats elapsed, I define these variables and constants:

b — the number of beats elapsed;

B — the total number of beats over which the tempo-glissando occurs;

T — the tempo at b (expressed in beats-per-minute);

T_0 — the initial tempo, at the start of the tempo-glissando (when $b = 0$);

T_B — the final tempo, at the end of the tempo-glissando (after B beats);

t — the elapsed time (expressed in *minutes*: one must multiply the quantity arrived at for t by a factor of 60 if one wishes to convert it into *seconds*);

d — the total duration (in minutes) over which the tempo-glissando runs, at $b = B$ (and also at $T = T_B$);

n — some positive integer: 1, 2, 3, ... ; n is a variable that can be used to alter the basic contour of a tempo-glissando;

c , c_0 , c_1 , etc. — various unspecified constants, which mostly arise from the computational process of integration or further calculation; c_0 will therefore be the ‘initial condition’ constant, at $t = 0$ (and at $b = 0$).

It is usually advisable (by solving a *differential equation*) to establish formulae for t as a function of T or in terms of b – in which case one writes: $t = f(T) = g(b)$ – so that $d = f(T_B) = g(B)$ in particular is able to be computed. Such calculations do become obligatory if one intends d or any subsectional durations traversed by the tempo-glissando

to fall in to some predetermined proportional relationship with certain time-spans. Indeed – more generally – if the equations for t are known, then by modifying the appropriate variables (or constants) within the tempo-glissando formulae so as to reshape its contour, one can thereby circumvent a situation where some (sub)section is too long or too short in comparison with another. (Similar numerical tweakings could also be required whenever d itself is preordained, as, for example, within a sound-track to a scene that lasts a given period in a film – and so forth.) However, for the most intractable circumstances of formal disproportion brought about by tempo-glissandi, to secure a desirable contour of tempo-evolution while at the same time achieving proper durational balance, one might even be compelled to select another class of tempo-glissando equations altogether.

Let us elicit t from the formulae for T and for b forthwith. Now $T = T(b)$, a function of b ; thus $b = U(T)$ where U is the *inverse function* of $T(b)$. Moreover, b itself is a function of time: i.e. $b = b(t)$. Yet it is also the case that $T = b'(t)$, where $b'(t)$ is the *first derivative* of $b(t)$ with respect to t . So $b'(t) = T = T(b)$, whence we procure the differential equation: $(T(b))^{-1} \times b'(t) = 1$. Integrating throughout, we then obtain:

$$\int ((T(b))^{-1} \times b'(t)) dt = \int 1 dt = \int dt ; \text{ i.e. } \int (T(b))^{-1} db = \int dt = t + c_0.$$

Now we need to define a new function, $S(b)$, such that $S'(b) = (T(b))^{-1}$. i.e. $S(b)$ is the *indefinite integral* of $(T(b))^{-1}$. Thus:

$$S(b) = \int (T(b))^{-1} db = t + c_0.$$

Therefore, setting $b = 0$ (when also $t = 0$), we deduce that the constant $c_0 = S(0)$, and so we have $S(b) = t + S(0)$. Hence: $t = S(b) - S(0) = S \circ U(T) - S(0)$; i.e. t can be evaluated as a function either of b or of T . In particular, putting $b = B$ and $T = T_B$, we conclude that: $d = S(B) - S(0) = S \circ U(T_B) - S(0)$.

With the specific genera of tempo-glissando equations which now follow, I shall mercifully skip all of the calculus and simply state the pertinent formulae without proof.⁶

1. The rate of change of T with respect to t is constant

The formulae below correspond to the well-known equations of motion (for displacement, velocity, and for acceleration) governed by the force of gravitation; these were all ascertained centuries ago by Galileo Galilei and Sir Isaac Newton. Here, $b''(t)$, the *second derivative* of $b = b(t)$, is equal to some constant c for all values of $t \geq 0$:

$b''(t) = T'(t) = c$, so that $T(t) = T_0 + c \times t$ and so $b(t) = T_0 \times t + c \times t^2 \div 2$.

It turns out that $c = ((T_B)^2 - (T_0)^2) \div (2 \times B)$ whereby

$T = T(b) = ((T_0)^2 + ((T_B)^2 - (T_0)^2) \times b \div B)^{1/2}$ and $t = (T - T_0) \times 2 \times B \div ((T_B)^2 - (T_0)^2)$ so that, in particular, $d = 2 \times B \div (T_0 + T_B)$.

For example, within these tempo-glissando equations: let $B = 101$ beats, $T_0 = 57$ beats-per-minute, and $T_B = 188$ beats-per-minute. Then: $d = 2 \times 101 \div (57 + 188) = 202 \div 245 \approx 0.824489795$ minutes ≈ 49.47 seconds.

2. T is an n th-degree polynomial function of b

The general tempo-glissando equation here is therefore:

$$T = T(b) = T_0 + (T_B - T_0) \times b^n \div B^n.$$

However, there is, unfortunately, no single generalized formula for t in terms of n and T (or n and b): t just has to be laboriously derived on a case-by-case basis for $n = 1$, $n = 2$, $n = 3$, etc.⁷ In **A World of Becoming**, we shall examine only the first, comparatively straightforward case, where $n = 1$ – for which T is a *linear function* of b :

$$T = T(b) = T_0 + (T_B - T_0) \times b \div B, \text{ whereby}$$

$$t = \ln(T \div T_0) \times B \div (T_B - T_0)$$

$$= \ln(1 + b \times (T_B - T_0) \div (T_0 \times B)) \times B \div (T_B - T_0). \text{ So:}$$

$$d = \ln(T_B \div T_0) \times B \div (T_B - T_0).$$

For instance, within the above tempo-glissando formulae, again let $B = 101$ beats, $T_0 = 57$ beats-per-minute, and $T_B = 188$ beats-per-minute. Then now:

$$d = \ln(188 \div 57) \times 101 \div (188 - 57) \approx 0.920095115 \text{ minutes} \approx 55.21 \text{ seconds.}$$

As a substantive illustration of this equational category being implemented within one of my pieces from **A World of Becoming**, consider the final tempo-glissando in **Arcturus Timespace**, which is just a steady *rallentando* controlled – apparently – by the linear function $T = T(b) = 80 - b$:

ARCTURUS TIMESPACE, SECTIONS E TO F

$B = 40.5 \approx 40$; $T_0 = 80$; $T_B = 40$.

Tempo-glissando formula [reconstructed]: $\approx T = T(b) = 80 + (40 - 80) \times b \div 40 = 80 - b$.

$d \approx \ln(40 \div 80) \times 40 \div (40 - 80) = \ln 0.5 \times -1 \approx 0.69314718$ minutes ≈ 41.59 seconds.

b	Tempo	b	Tempo	b	Tempo
0 ♪	♪ = ca.80	10.5 ♪	♪ = ca.70	28.5 ♪	♪ = ca.52
3 ♪	♪ = ca.77	14.5 ♪	♪ = ca.66	32.5 ♪	♪ = ca.48
7 ♪	♪ = ca.73	18.5 ♪	♪ = ca.62	36.5 ♪	♪ = ca.44
9 ♪	♪ = ca.71	22.5 ♪	♪ = ca.58	40.5 ♪	♪ = ca.40

3. *T forms an equal-tempered tempo-scale between T_0 and T_B that is divided into B equal ‘tempo-intervals’*

With this postulate, our tempo-glissando formula is:

$T = T(b) = T_0 \times (T_B \div T_0)^{(b \div B)}$, from which we infer

$t = (T - T_0) \times B \div (T \times T_0 \times \ln(T_B \div T_0))$

$= B \div (T_0 \times \ln(T_B \div T_0)) \times (1 - (T_0 \div T_B)^{(b \div B)})$. Therefore:

$d = (T_B - T_0) \times B \div (T_B \times T_0 \times \ln(T_B \div T_0))$.

For example, within such tempo-glissando equations, yet again let $B = 101$ beats, $T_0 = 57$ beats-per-minute, and $T_B = 188$ beats-per-minute. Then now:

$d = (188 - 57) \times 101 \div (188 \times 57 \times \ln(188 \div 57)) \approx 1.034611538$ minutes

≈ 62.08 seconds.

With a tempo-glissando that slides through an equal-tempered scale of tempi, whenever the sounds through which it is articulated themselves evince equal-tempered intonations, then *unity* is upheld by an identity of paradigm – equal temperament – being brought to bear upon distinct compositional facets. Such unity embraces an *abstract self-similarity* between pitch-structure (as an aspect of frequency, in the time domain) and tempo-shift (from the ‘tempo domain’).

Perhaps unexpectedly, equal-tempered tempo-glissandi are by no means of recent provenance. More than forty years ago, Elliott Carter composed one to begin the sixth variation of his **Variations for Orchestra** (1954–1955):

There is a very simple example in [Elliott] Carter’s **Variations for Orchestra** (Variation 6), where the following metronome settings appear on successive measures (under the general instruction “Accel. molto”):

♩ = 80, 96, 115, 139, 166, 201, ♩. = ♩ = 80 etc.;

the ratios between adjacent numbers approximate $\sqrt[6]{3}$ [≈ 1.200936955]. An equal-tempered tempo scale is notated, as a means of suggesting a steady tempo glissando. [Accurate to two decimal places, the ideal equal-tempered tempo-values based upon a ratio of $\sqrt[6]{3}$ would be: 80.00, 96.07, 115.38, 138.56, 166.41, 199.84, 240.00, etc.] ... More complex and subtler applications of the same approach to tempo relationships – an approach which is complementary and antithetical to “metric modulation” – are not uncommon in Carter’s [then] recent music; see, for example, the **Second String Quartet**, p.55.⁸

4. The formula for T APPROXIMATES an equal-tempered tempo-scale between T_0 and T_B of B equal ‘tempo-intervals’

This infinitely large set of equations for tempi exhibits the felicitous property of possessing tempo-change contours which approximate, to whatever degree one desires, the shape of the curve of the previously discussed formula for equal-tempered tempo-scales, $T = T(b) = T_0 \times (T_B \div T_0)^{(b \div B)}$. The general equation for this new (but cognate) tempo-glissando category is:

$$T = T(b) = ((T_0)^{r^{-1}} + ((T_B)^{r^{-1}} - (T_0)^{r^{-1}}) \times b \div B)^r$$

wherein r is any real number such that $r \neq 0$ and $r \neq 1$.⁹

This variable r modulates the contour of $T(b)$.¹⁰ So:

$$t = (T^{(r^{-1} - 1)} - (T_0)^{(r^{-1} - 1)}) \times B \div ((1 - r) \times ((T_B)^{r^{-1}} - (T_0)^{r^{-1}})), \text{ in which case}$$

$$d = ((T_B)^{(r^{-1} - 1)} - (T_0)^{(r^{-1} - 1)}) \times B \div ((1 - r) \times ((T_B)^{r^{-1}} - (T_0)^{r^{-1}})).$$

For instance, within these convoluted tempo-glissando formulae, let $B = 101$ beats, $T_0 = 57$ beats-per-minute, and $T_B = 188$ beats-per-minute (just as before). Our new variable r we shall set, for no particular reason, at $r = -5$. Then:

$$d = (188^{-1.2} - 57^{-1.2}) \times 101 \div (6 \times (188^{-0.2} - 57^{-0.2})) \approx 1.058695707 \text{ minutes} \\ \approx 63.52 \text{ seconds.}$$

Apart from obviously working with different values for the constants B , T_0 and T_B , it is this very class of tempo-glissandi formulae, i.e.

$$T = T(b) = ((T_0)^{r^{-1}} + ((T_B)^{r^{-1}} - (T_0)^{r^{-1}}) \times b \div B)^r$$

with $r = -0.75$, that I relied upon repeatedly to mould tempo-glissandi within both

Echoes/Fantasies and Cycles of Vega.¹¹ In selecting this specific equation for T(b), tempi were tabulated and plotted on graph paper against beats elapsed using various quantities (positive and negative) for r; the beats were then tallied out aloud while I painstakingly revolved the tempo-selection dial on my electronic metronome accordingly. Within the above general formula, the amount -0.75 was chosen for the variable r on account of the resulting formula's gradient of tempo-development – which simply 'felt right'.

It is apt that $T = T(b) = ((T_0)^{r^{-1}} + ((T_B)^{r^{-1}} - (T_0)^{r^{-1}}) \times b \div B)^r$ for **Cycles of Vega** in particular is only an *approximation* of an equal-tempered tempo-scale, since many of this work's microtonal pitches themselves merely approximate 12- or 24-tone equal temperament: abstract self-similarity and compositional unity are thereby preserved:

CYCLES OF VEGA, SECTIONS G TO I

B = 188; $T_0 = 43$; $T_B = 134$. Erroneous interpolated tempi have been underlined.

Tempo-glissando formula: $T = T(b) = (43^{-0.75^{-1}} + (134^{-0.75^{-1}} - 43^{-0.75^{-1}}) \times b \div 188)^{-0.75}$.

$d = (134^{(-0.75^{-1} - 1)} - 43^{(-0.75^{-1} - 1)}) \times 188 \div (1.75 \times (134^{-0.75^{-1}} - 43^{-0.75^{-1}}))$
 ≈ 2.976023433 minutes ≈ 178.56 seconds.

b	Tempo	Ideal	b	Tempo	Ideal	b	Tempo	Ideal
0 ♪	♪ = ca.43	43.00	99 ♪	♪ = ca.64	ca.63.95	147.5 ♪	♪ = ca.88	ca.87.50
5 ♪	♪ = ca.44	ca.43.68	103 ♪	♪ = ca.65	ca.65.33	149.5 ♪	♪ = ca.89	ca.88.93
13 ♪	♪ = ca.45	ca.44.83	105 ♪	♪ = ca.66	ca.66.05	151.5 ♪	♪ = ca.90	ca.90.42
21.5 ♪	♪ = ca.46	ca.46.12	107 ♪	♪ = ca.67	ca.66.79	153.5 ♪	♪ = ca.92	ca.91.97
26.5 ♪	♪ = ca.47	ca.46.93	111 ♪	♪ = ca.68	ca.68.32	155.5 ♪	♪ = ca.94	ca.93.58
30.5 ♪	♪ = ca.48	ca.47.59	113 ♪	♪ = ca.69	ca.69.13	157.5 ♪	♪ = ca. <u>96</u>	ca.95.26
38.5 ♪	♪ = ca.49	ca.49.00	115.5 ♪	♪ = ca.70	ca.70.16	159.5 ♪	♪ = ca.97	ca.97.01
45 ♪	♪ = ca.50	ca.50.21	118.5 ♪	♪ = ca.71	ca.71.44	161.5 ♪	♪ = ca.99	ca.98.83
50 ♪	♪ = ca.51	ca.51.20	120.5 ♪	♪ = ca.72	ca.72.33	163.5 ♪	♪ = ca.101	ca.100.74
53.5 ♪	♪ = ca.52	ca.51.91	122.5 ♪	♪ = ca.73	ca.73.25	165.5 ♪	♪ = ca.103	ca.102.74
57.5 ♪	♪ = ca.53	ca.52.76	124.5 ♪	♪ = ca.74	ca.74.19	167.5 ♪	♪ = ca.105	ca.104.83
61.5 ♪	♪ = ca.54	ca.53.64	126.5 ♪	♪ = ca.75	ca.75.16	169.5 ♪	♪ = ca.107	ca.107.02
65.5 ♪	♪ = ca.55	ca.54.55	128.5 ♪	♪ = ca.76	ca.76.16	171.5 ♪	♪ = ca.109	ca.109.33
69.5 ♪	♪ = ca.56	ca.55.50	130.5 ♪	♪ = ca.77	ca.77.19	173.5 ♪	♪ = ca.112	ca.111.75
77.5 ♪	♪ = ca. <u>57</u>	ca.57.53	132.5 ♪	♪ = ca.78	ca.78.26	175.5 ♪	♪ = ca.114	ca.114.30
81.5 ♪	♪ = ca. <u>58</u>	ca.58.61	135 ♪	♪ = ca.80	ca.79.64	177.5 ♪	♪ = ca.117	ca.116.99
83.5 ♪	♪ = ca.59	ca.59.17	137 ♪	♪ = ca.81	ca.80.78	179.5 ♪	♪ = ca.120	ca.119.84
85.5 ♪	♪ = ca.60	ca.59.74	139 ♪	♪ = ca.82	ca.81.97	181.5 ♪	♪ = ca.123	ca.122.85
89.5 ♪	♪ = ca.61	ca.60.92	141 ♪	♪ = ca.83	ca.83.20	183.5 ♪	♪ = ca.126	ca.126.05
94 ♪	♪ = ca.62	ca.62.31	144 ♪	♪ = ca.85	ca.85.12	184 ♪	♪ = ca.127	ca.126.87
97 ♪	♪ = ca.63	ca.63.28	146 ♪	♪ = ca. <u>87</u>	ca.86.46	188 ♪	♪ = ca.134	134.00

CYCLES OF VEGA, SECTIONS I TO M

B = 66; T₀ = 67; T_B = 40.

Tempo-glissando formula: $T = T(b) = (67^{-0.75^{-1}} + (40^{-0.75^{-1}} - 67^{-0.75^{-1}}) \times b \div 66)^{-0.75}$.

$d = (40^{(-0.75^{-1} - 1)} - 67^{(-0.75^{-1} - 1)}) \times 66 \div (1.75 \times (40^{-0.75^{-1}} - 67^{-0.75^{-1}}))$
 ≈ 1.326948676 minutes ≈ 79.62 seconds.

b	Tempo	Ideal	b	Tempo	Ideal	b	Tempo	Ideal
0 ♪	♪ = ca.67	67.00	18 ♪	♪ = ca.56	ca.56.01	44 ♪	♪ = ca.46	ca.45.82
2 ♪	♪ = ca.66	ca.65.53	20 ♪	♪ = ca.55	ca.55.04	48 ♪	♪ = ca.45	ca.44.62
4 ♪	♪ = ca.64	ca.64.14	22 ♪	♪ = ca.54	ca.54.11	51 ♪	♪ = ca.44	ca.43.76
7 ♪	♪ = ca.62	ca.62.17	24 ♪	♪ = ca.53	ca.53.21	55 ♪	♪ = ca.43	ca.42.68
9 ♪	♪ = ca.61	ca.60.93	26 ♪	♪ = ca.52	ca.52.35	58 ♪	♪ = ca.42	ca.41.91 †
11 ♪	♪ = ca.60	ca.59.75	29 ♪	♪ = ca.51	ca.51.11	62 ♪	♪ = ca.41	ca.40.93
12 ♪	♪ = ca.59	ca.59.18	33 ♪	♪ = ca.50	ca.49.57	66 ♪	♪ = ca.40	40.00
14 ♪	♪ = ca.58	ca.58.08	36 ♪	♪ = ca.48	ca.48.48			
16 ♪	♪ = ca.57	ca.57.02	40 ♪	♪ = ca.47	ca.47.11			

† NB: bar 208, which is 'senza tempo', suspends the tempo-glissando process.

ENDNOTES

EPIGRAPH

1. Quoted from Bligh Bond & Lea (1977), Epigraph.

SECTION 1.1

1. Bester (1981), p.303.
2. Sculthorpe (1999); Lambert (1985); etc.
3. John D. Barrow: **Pi in the Sky: Counting, Thinking and Being** (1992), pp.251–265 (and *passim*).
4. Read Sokal & Bricmont (1999) for a closely reasoned debunking of postmodern theories.
5. Michell (1988), p.48.
The perennial tenet expressed here by Nicomachus of Gerasa, that number in its transcendent, immutable abstraction underpins our physical existence, is also epitomized poetically by Plato in the **Epinomis**, 991E1–4: “Every diagram, system of numbers, every scheme of harmony, every law of the movement of the stars, ought to appear as one to him who studies rightly”.
6. Graham Pont: “Analogy in Music: Origins, Uses, Limitations”; in ed. Kassler (1991), p.193.
7. Graham Pont, *op. cit.*, p.194.
8. John D. Barrow, in his book **Pi in the Sky: Counting, Thinking and Being** (1992), discusses the twentieth-century logician Kurt Gödel’s theorems, which reveal the intrinsic constraints of ‘proof’ within all axiomatic systems from mathematics (and thereby limit our ‘scientific knowability’). See also Rucker (1997), pp.157–171 & pp.267–294.
9. Graham Pont, *op. cit.*, pp.195–196.
10. Michell (1988), p.200: “... The universe as an organism is a creature of paradox, never entirely predictable, whereas a rational cosmology must be self-consistent. Plato in **Parmenides** showed that for every general statement which can be made about the universe the opposite statement is equally tenable, thus invalidating all approaches to cosmology which fail to allow the upholding of two contrary ideas at the same time. That necessity is symbolized by the interlaced square and circle at the foundation of the New Jerusalem. ...”
11. Graham Pont, *op. cit.*, p.201.
12. John D. Barrow: **Pi in the Sky: Counting, Thinking and Being** (1992), p.7.
13. Stewart (1996), pp.55–57.
14. I emphatically declare, *en passant*, that this word ‘complexity’ is by no means intended to convey any musicological resonances or musico-political baggage here.
15. Consult Lewin (1993), pp.10–13 and *passim*.
16. See Appendix 2 of **A World of Becoming**.
17. Henry Chadwick – in Chadwick (1986), p.21 – observes that “[the Neoplatonist philosopher] Porphyry taught that God contains all things but is contained by nothing. The One is present to all that participate in the existence flowing from its source in God. ... But all plurality depends upon and seeks to return to higher and prior unity. In the hierarchy of being it is axiomatic that it is good to exist, [but] that degrees of being are also degrees of goodness. Porphyry wrote that ‘everything which has being is good in so

far as it has being; even the body has its own beauty and unity”.

18. Such a radical panentheistic belief – that in Jesus Christ, our Universe (and everything within it) is ongoingly held together, and that through Christ the Creative Logos, all things are reconciled to himself – is affirmed by the apostle Paul in Colossians 1:15–20.
19. Chadwick (1986), p.71.
20. Peters (1999), p.110 – quoting Karlheinz Stockhausen.
21. Evelyn Underhill: “Mysticism and Theology” (from **Mysticism**); in ed. Pelikan (1990), p.527. (I have since acquired a facsimile edition of the primary source – Evelyn Underhill’s *magnum opus* **Mysticism: The Nature and Development of Spiritual Consciousness** (1999 reprint); the quoted passage is from p.97 therein.)
22. Evelyn Underhill, *op. cit.*, p.529; Underhill (1999), p.99.
23. By analogy, focussing upon the human zone from the Universe’s spectrum, S. T. Georgiou – in Georgiou (1994), p.41 – writes about a Platonic idea wherein “the immortal soul is continually in a state of ‘becoming’ in its comprehension of imperishable truths”. We shall cast some light upon other such cosmic-anthropic correlations elsewhere throughout **A World of Becoming**.
24. Evelyn Underhill, *op. cit.*, pp.530–531 & p.533; Underhill (1999), p.101 & pp.103–104.

That such a happy panentheistic resolution may be achieved between the theologies of Immanence and of Emanation, to harmonize our ostensibly conflicting intuitions of God’s omnipresence with that of the ineffable transcendence of the Godhead, is encapsulated elegantly – in ed. Backhouse (1992), p.138 – by one of Meister Eckhart’s apophthegms: “... God is not only the Father of all good things, but he is the mother of all things as well. He is Father, for he is the [transcendent] cause of all things and their creator. He is the mother, for when creatures have received their being from him he still stays with them [as the one who is Immanent] to keep them in being. ...”

The unific Christian theology of panentheism is surveyed at some length in Philip Clayton’s monograph **The Problem of God in Modern Thought** (2000), and particularly in Matthew Fox’s marvellous book **The Coming of the Cosmic Christ** (1988).
25. Virtual structures from my compositional *œuvre* will be addressed elsewhere within **A World of Becoming**.
26. Fox (1991), p.10.
27. Concerning the various complexities of Zionism, John Michell – in Michell (1988), pp.209–210 – writes: “... Jerusalem is now most widely acknowledged as the *omphalos* or sacred centre of this planet. To followers of the three most powerful religions in the West, ... it is a shrine of unique importance. ... Its legends, the features of its sacred geography and its very name (meaning in Hebrew Peace and Wholeness) identify it as the earthly type of the Heavenly City. This identification is strongly supported by history. Throughout our era Jerusalem has been the goal and inspiration of innumerable chiliastic and idealistic movements, from the Christian crusades to modern Jewish Zionism. The declared aim of esoteric groups such as the Freemasons and the Knights of St John is the rebuilding of Jerusalem’s Temple, by which is symbolized restoration of the traditional code of philosophy and the ideal reordering of human society. The present situation in Jerusalem is that the Jewish state of Israel is politically in the ascendancy, supporting an exclusive form of Zionism which would make Jerusalem a predominantly Jewish city to the disadvantage of its other inhabitants and the Muslim [and Christian] sanctuaries there. From the perspective of traditional philosophy a lack of balance is apparent, and that deficiency is symptomized by the chronic unrest which marks modern Jerusalem as the point of confrontation between rival forces. In order to prove whether the philosophy inherent in [the study] of the Heavenly Jerusalem is capable of serving any useful purpose, it has to be put to the test. And the most obviously suitable testing ground is Jerusalem on earth. The inspiration for these final remarks is the thoughts and writings of Dr Yitzhak Khayutman, one of the planners of modern Israel and member of a group concerned with the nature and true meaning of Zionism. Zion is Jerusalem, and Zionism is therefore nothing more or less than Jerusalem-ism. It can thus be ascribed to the very people who proclaim themselves most hostile to it. The Palestinians who seek to regain and retain their share of Jerusalem are by that token Zionists; so are the Baptists and many other Christian sects who call themselves Israelites and aspire to a place in the Holy City; and even the fierce Iranians, whose declared intention is to march on Jerusalem and expel the Jews, have thereby adopted Zionism – in its exclusive aspect. ... [T]he two sides in any dispute, once they are clearly defined, make up an entity,

like the two sides of a coin. Their interests are not merely rivals but also complement each other. ... When all parties to the dispute over the earthly Jerusalem are brought to realize that each of them represents a form of Zionism, a reasonable accommodation between them is within reach. Dr Khayutman's approach to the problem of pacifying the Middle East under conditions of lasting stability starts with his proposed redefinition of Zionism as 'the actualization of the Heavenly Jerusalem on earth'. ..."

28. Michell (1988), p.210.
29. This, as well as my painstaking attention to detail, accounts for the fact that I compose *very slowly*. (Nevertheless, I must admit that there have been a few exceptions: **Arc of Light**, **Cathy's Song** and **Lingua Silens Florum** were each completed within a day!)
30. Job 36:26 proclaims: "How great is God – beyond our understanding!". (The prophet Ezekiel's poetic vision of God, in Ezekiel 1, is also a paragon of complexity.)
31. Such a theologico-musical approach stands in stark contrast to that of certain contemporary European colleagues (Arvo Pärt and John Tavener in particular) who instead advocate a radical simplicity throughout their music. See, for example, John Tavener: "The Sacred in Art", and Jamie McCarthy: "An Interview with Arvo Pärt"; in ed. Moody (1995), pp.49–54 & pp.55–64 respectively.
32. Apophatic theology is surveyed in Louth (1981), pp.173–178 and *passim*.
- 32b. Almost unbelievably, this mystical, apophatic approach to God – whose Absolute Infinity is beyond human reach – finds some support in the relatively modern Theory of Transfinite Numbers, that branch of mathematics which operates with various infinities. Georg Cantor, the 'discoverer' (during the late 1800s) of transfinite numbers, recognized the actual existence of an Absolute Infinity – aptly symbolized by Ω – that abides beyond all other infinite magnitudes. According to Rucker (1997), p.9, "Cantor ... distinguishes between the Absolute Infinite, the physical infinities, and the mathematical infinities: 'The actual infinite arises in three contexts: *first* when it is realized in the most complete form, in a fully independent other-worldly being, *in Deo*, where I call it the Absolute Infinite or simply Absolute; *second* when it occurs in the contingent, created world; *third* when the mind grasps it *in abstracto* as a mathematical magnitude, number, or order type. I wish to make a sharp contrast between the Absolute and what I call the Transfinite, that is, the actual infinities of the last two sorts, which are clearly limited, subject to further increase, and thus related to the finite'".

Rucker continues: "Part of the great attractiveness of Cantor's theory stems from the fact that all of his transfinite numbers can be seen as steps towards the single Absolute Infinity that lies beyond them all. Indeed, ... modern formalizations of set theory often proceed by introducing a symbol Ω for Absolute Infinity and by then assuming the Reflection Principle: every conceivable property of Ω is shared by some ordinal less than Ω The Reflection Principle is really a different way of saying ' Ω is inconceivable' ... To sum up, we justify Cantor's transfinities from the two assumptions: i) there is an Absolute Infinity, Ω ; ii) Ω is inconceivable. ..." (*ibid.*, p.80); "What is Ω ? Ω is what people are talking about when they speak of infinity in the sense of something subject to no limitation of any kind. Ω is Absolute Infinity. Absolutes are by their very nature not rationally or objectively knowable in full. ..." (*ibid.*, p.224); "... I use the symbol Ω to stand for the end of the path, the last ordinal, the Absolute Infinite, 'that than which no greater can be conceived'. ..." (*ibid.*, p.253); "... The problem of how we *do* talk about such inconceivable things as the Absolute Infinite [Ω] is an extremely deep and beautiful question ... As ungraspable Absolute, Ω is Many, yet as a single guiding idea it is One. ..." (*ibid.*, p.254); "... Plotinus held that [this] One could not be limited in any sense. As [St Thomas] Aquinas, the quintessential theologian, says: 'The notion of form is most fully realized in existence itself. And in God existence is not acquired by anything, but God is existence itself subsistent. It is clear, then, that God himself is both limitless and perfect'. The limitlessness of God is expressed in a form closer to the mathematical infinite by St Gregory: 'No matter how far our mind may have progressed in the contemplation of God, it does not attain to what He is, but to what is beneath Him'. ..." (*ibid.*, p.44). Consult also *ibid.*, pp.44–51 and *passim*, as well as Clayton (2000), concerning the idea of the Absolute Infinite.
33. Here we can behold two significant criteria for distinguishing between natural and man-made structures: the latter often adopt quite precise repetitions within a form that possesses relatively few perceptible architectonic strata. (This point is well illustrated by comparing, for example, a fern's patterns with that of a brick wall.)
34. Saunders Smith & Goldstein (1998), pp.188–191.
35. Interestingly, the Greek equivalent is *harmonia* – 'harmony': a "fitting together".

36. Zuckerkandl (1969), pp.376–377.
37. ed. Lang (1962), p.7.
38. The abstruse concept of mathematical ‘undecidability’ – a direct consequence of Kurt Gödel’s incompleteness theorems – is examined throughout Penrose (1990), Rucker (1997), and in John D. Barrow’s book **Pi in the Sky: Counting, Thinking and Being** (1992), pp.137–138 (and *passim*).
39. A commonplace example: enharmonic accidentals in (tonal) piano music, though denoting identical piano keys to be struck, also furnish information about a work’s harmonic direction.
40. For instance, the notation of time within **Dimensiones Paradisi** clearly discloses ‘bifurcated tuplets’ and – through the employment of unique “intercut bar-lines” – interruptive structural insertions: much of this piece’s chronomorphology is unmasked by its symbology. (See also Brian Ferneyhough: “Aspects of Notational and Compositional Practice”; in ed. Boros & Toop (1995), pp.2–13.)
41. Dench (1997), p.96.
42. Conversely, maybe those composers who are untroubled by grosser notational ‘approximations’ are more Aristotelian in their outlook?
43. Compare the score of **Zodiac: Crystal Orbit Improvisations** with that of **Dimensiones Paradisi**, for example.
44. Cott (1974), pp.14–15. The first statement by Anton Webern here is quoted in its entirety – as found in *ibid.*, p.224.
45. For true *listeners* within the community, I contend that composing music is an *act of generosity*. As such, I am completely opposed to any ethos that denies people access to works of art on the grounds of their impecuniousness. Material poverty should never be a criterion for prohibiting anybody’s exposure to, and appreciation of, music – particularly its live performance.
46. This dissenting view is fleshed out in my essays comprising Appendix 1 and Appendix 2 of **A World of Becoming**. (Typified by very strong and colourful language, such erstwhile writings – from which I do not resile – ought to be appraised as ‘snapshots’ of the years during which they were written, when my attitude to life and culture was considerably darkened by the bleakness of an overpowering Gnostic pessimism.)

Note also that Appendices 3–8 within **A World of Becoming** have been included merely to provide additional pertinent information about the author, thereby expanding this doctoral thesis into a reasonably comprehensive ‘time-capsule’ of my life and work to date.
47. I absolutely agree with the Welsh composer Richard Barrett, who declares – in Toop (1988), p.36 – that “... the deployment of real intelligence in music is a subversive act in itself”.
48. Furthermore, those present-day composers of art-music who claim to ‘give the audience what it wants’ are either deluded or dishonest. It is dishearteningly clear that, as we move into the twenty-first century, the vast majority of people do not wish to hear *any* contemporary art-music at all: most consumers now seem to prefer ‘classical music’ from previous centuries or some form of demotic twentieth-century music. So, logically, these ‘slave-composers’ – if they really do desire to indulge a large cross-section of the public – should either *stop composing*, or instead, if they possess the aptitude, switch to penning country-and-western tunes (or some other fashionable style of vernacular ephemera).
49. Chris Dench: “... ‘the composer becomes a cartographer’ ...”; in ed. Broadstock (1995), p.287.
50. Shanahan (1997), p.10.
51. Admittedly though, for some reason such reticence has not materialized in relation to my piano music or my compositions for solo recorder.
52. The English scholar Nicholas Cook writes – in Cook (1998), p.74 – that “... the classical orchestra and its evolution reproduces the organizational structures of contemporary society”. If so, then from *my* perspective, this is a calamitous condition – one which drives yet another nail into the coffin of the orchestra.

53. **Thunder, Perfect Mind** (Nag Hammadi Codex VI.2, 4th century AD), 14:12–15; in ed. Robinson (1990), p.298.
54. Further clarification of this idea within **A World of Becoming** is imparted by these works' Programme Annotations.
55. Heraclitus, **Fragment 123**: "The nature of things is in the habit of concealing itself"; in Philip K. Dick: **VALIS** (1991), p.39.
56. Heraclitus again, **Fragment 54**: "Latent structure is master of obvious structure"; *ibid.*
57. Hence throughout my analyses within **A World of Becoming**, instead of providing specific mathematical expressions such as $\pi + \sqrt{7}$ (for instance), I shall only divulge (approximate) decimal expansions of numerical constants, proportions, and geometric relations.

SECTION 1.2.1

1. For a deeper mathematical inquiry into the subject of permutations, readers are encouraged to consult the outstanding explication of the theory of *permutation groups* in I. N. Herstein's textbook **Topics in Algebra** (1975), pp.75–82.
2. For a more detailed discussion concerning Messiaen's interventions and permutational praxis, see Robert Sherlaw Johnson's monograph **Messiaen** (1984) and Larry W. Peterson's doctoral dissertation **Messiaen and Rhythm: Theory and Practice** (1973).
3. One historic precursor for such an algorithmic yet independent permuting of musical materials that bridge two or more compositional 'dimensions' (whereby a different cyclic group controls each 'parameter') is the coda of Karlheinz Stockhausen's **Klavierstück VII** (1954), wherein an ordered set of five pitches [$A_4 = 5$, $G_4 = 2$, $D_5 = 3$, $G_5 = 4$, $F_4 = 1$] is repeatedly rearranged by the permutation $\Omega = (1, 5, 2, 3, 4)$ whilst this pitch-set's five distinct durations – these being integer multiples, from 1 to 5, of a demisemiquaver *chronos protos* – autonomously parade in turn all five elements of the cyclic group $\langle \Delta \rangle$ whose defining permutation $\Delta = (1, 2, 3, 4, 5)$ operates upon the coda's initial rhythm $R = \Delta^0 = [4, 2, 5, 3, 1]$. Moreover, if we now assign the natural number correspondences $ppp = 1$, $pp = 2$, $p = 3$, $mp = 4$ and $mf = 5$, then this music's dynamic indications unfurl here four of the five elements of yet another cyclic group, $\langle \Pi \rangle$, where the permutation $\Pi = (1, 2, 5, 4, 3)$ re-orders a dynamic-series $S = \Pi^0 = [1, 4, 2, 3, 5]$. In summary, therefore, Stockhausen concludes his **Klavierstück VII** with the permutational members of three cyclic groups – $\langle \Omega \rangle$, $\langle \Delta \rangle$, and $\langle \Pi \rangle$ – that independently shuffle pitches, durations and dynamic levels, respectively.

Decarsin (1998), p.20 displays the final score-page from **Klavierstück VII**, together with some helpful numerical annotations. Concerning this work's grid of serial processes, Decarsin avers (*ibid.*, pp.19–21) that "... the coda of **Klavierstück VII** (1954) constitutes a perfect example of this new way of writing: five pitches, five intensities, and five durations are distributed in five articulated groups, with each note in a register of its own ... the ear simultaneously grasps the immutability of the envelope and all the permutations which occupy it. The isolated sounds, compared at that time to stars (the image is from the critic Herbert Eimert), move about according to combinatorial rules which are simultaneously playful [yet] rigorous".

4. To me, this permutation technique's metaphoric power as well as its capacity to produce a cornucopia of algebraically interrelated materials from which one can draw, are at least as salient as any problems here concerning cognition.
5. In contemporary musical (as opposed to mathematical) terminology, 'irrational' durations are simply *non-binary*: they are never procured by dividing or multiplying some given tactus by two or any higher power of two. 'Irrational' durations therefore embrace all of the so-called 'tuplets' – triplets, quintuplets, sextuplets, septuplets, etc.
6. Does this activity not resemble the mystical practices of certain thirteenth-century Jewish Kabbalists, such as Abraham Abulafia, who aspired to the secret Names of God through meticulously permuting Hebrew letters? See Gershom Scholem's definitive study **Kabbalah** (1987) for a thoroughgoing survey of Kabbalah.

From recent times, Arthur C. Clarke's celebrated fable **The Nine Billion Names of God** (1953) tells of Tibetan lamas who use a computer to print out every possible permutation of a set of sacred letters:

somewhere therein will appear each of the true, secret Names of God which, having been revealed by men, accomplishes the highest purpose of our physical existence – so that the Universe itself begins to shut down!

7. My own simile for such finitude bestowing great richness is the ‘finite infinity’ of c , the speed of light – which is, of course, numerically finite; but physically, c does behave like an infinity, in that every real velocity is less than it.
8. Herstein (1975), p.77.
9. Although specific pitches are notated throughout every part in **Zodiac: Crystal Orbit Improvisations**, (multi)octave transpositions may be implemented at any time.
10. An obvious precedent for revolving pitch-material in this way is Igor Stravinsky’s serial routine of ‘hexachord rotation’; less well known, however, is the fact that Stravinsky’s orchestral **Variations (Aldous Huxley In Memoriam)** of 1964 arrays rotations of complete twelve-tone series. In my own **Zodiac: Crystal Orbit Improvisations**, such rotations (of permutations) are not inappropriate – despite potentially inducing algebraic ambiguity upon a permutation group: the technique of pitch-rotation is inarguably a splendid ‘trope’ for astronomical periodicities.

11. Although certainly the abstract concept of ‘systematic permutation’ suffuses **Zodiac: Crystal Orbit Improvisations**, as a compositional tool for re-ordering pitch-classes, my thinking in regard to it was by no means always ‘quantal’: whenever this piece’s randomized parameters are brought to bear, one is not necessarily dealing any more with discrete pitches, but rather, at times, with tone-colours which might be smeared together within a continuous sonoric envelope – thus suggesting instead a somewhat more ‘analogue’ approach to sound-structure. See Wishart (1996), Chapters 1 & 2.

As further evidence for the ubiquity of ‘permutation’ in **Zodiac: Crystal Orbit Improvisations**, even the soprano recorder part’s menu of six distinct pauses – *ca.1"*, *ca.2"*, *ca.3"*, *ca.4"*, *ca.5"*, and *ca.6"* – illustrates a permutational structure, whereby each approximate pause-length is employed exactly twice. I scrambled their order, non-systematically, so as to secure a variety of hiatuses between adjacent “modules” therein.

12. I have been informed (orally) by Roger Dean – an acknowledged authority on late-twentieth-century improvisational practices and structures – that the hybrid term ‘comprovisation’ signifies ‘composition for improvisers’, and that this handy jargon recently originated from the U.S.A., where it continues to grow in popularity. Less informally within ed. Shanahan & Dench (1995), on p.15, Roger Dean reports: “I might call my work ‘comprovisation’. I plunder this term from the U.S., where it was pioneered a few years ago to refer to composing for improvisers”.
13. Matt (1995), p.102 – translated from the **Sefer Yetsirah** [“Book of Creation”] 2:2, 2:4–6, and 6:4 (3rd to 6th centuries AD).

According to Daniel C. Matt (*ibid.*, p.187), “The twenty-two letters [are those] of the Hebrew alphabet. Thus God created the world through numbers and letters [NB: in the ancient Hebrew language itself (and by *gematria*), each Hebrew letter is equivalent to a number], a cosmology combining the biblical view of creation by divine speech with the Pythagorean theory that numbers constitute the essential nature of things”. Matt continues his commentary (*ibid.*, pp.197–198): “God creates by combining and arranging the letters of the Hebrew alphabet in all possible ways. Many kabbalists, including Abraham Abulafia, sought to imitate this activity of letter permutation, based on the detailed instructions in **Sefer Yetsirah**. [Regarding the “231 gates”, 231 is the] number of two-letter combinations that can be formed from the twenty-two letters of the Hebrew alphabet, provided the same letter is not repeated [i.e. $231 = {}^{22}C_2 = 22! \div (20! \times 2!) = 22 \times 21 \div 2 = 11 \times 21$] ... [On the formation of everything from just a single name, the] entire [Hebrew] alphabet [is here] seen as [this] one name. Alternatively, the name is YHWH [the *Tetragrammaton*] ... [Concerning ‘ungraspable ether’, the] concept of the ether (Hebrew, *avir*, “air”) corresponds to Greek conceptions. Aristotle identified ether as an incorruptible, unchanging heavenly element found only in the region beyond the sphere of the moon. Rotating around the earth, the ether fills all of space. All the heavenly bodies – the sun, moon, planets, and stars – are composed of it, as are the rotating spheres in which these ethereal bodies are embedded. The Stoics identified the ether with *pneuma*, a quasi-material spiritual substance, which pervades not only heaven but all matter on earth, as well as transmitting light and gravity. Descartes’ “subtle matter” corresponds to the ether, as does the active vacuum field in contemporary particle physics ... In classical Kabbalah the ether is identical with the highest sefirah [i.e. the highest emanation from the ‘infinite God’, *Ein Sof*], also known as nothingness [*ayin*] – the creative nothingness out of which all being emerges. [The endearment of God towards Abraham] “Abraham, my beloved” [comes from] Isaiah 41:8. In imitating the divine act of creating with letters, Abraham becomes a model for later Jewish mystics. Traditionally, **Sefer Yetsirah**

is attributed to Abraham”.

On God’s Creation being accomplished through the medium of the twenty-two Hebrew letters, see also Ben Shahn’s delightful illustrated allegory **The Alphabet of Creation: An Ancient Legend from the Zohar [or Book of Splendour]** (1954).

SECTION 1.2.2

1. Hannan (1982), p.224.
2. Isorhythmic devices find their origins in the music of the fourteenth-century *Ars Nova*.
3. There is actually an overlap of three durations within the violoncello’s isorhythm here, so that these two time-cycles’ colotomies will always synchronize with each other again after every fifteen durations.
4. ed. Ridpath (1979), p.68.

In his encyclopaedic **Almagest**, Ptolemy of Alexandria (Claudius Ptolemaeus: ca.100–ca.178 AD) “discussed the motion of the planets and the layout of the Universe. He extended the star catalog of the great Greek astronomer Hipparchus with his own observations; and he discussed in detail whether or not the Earth is fixed in space, concluding that all evidence indicated it must be stationary. Ptolemy explained the movements of the planets using the basic concept of uniform motion in a circle, together with mathematical devices proposed in the third century BC by Apollonius of Perga. These made use of large and small circles (*deferents* and *epicycles*) and a movable eccentric (a large eccentrically mounted circle), and with them Ptolemy was able to describe all planetary motions in detail. A persuasive synthesis of all Greek astronomical knowledge, Ptolemy’s **Almagest** exerted a profound and lasting influence on all subsequent generations of astronomers. It would not be seriously challenged for 1,300 years” (*ibid.*, p.161).

On the fascinating subject of epicycles, consult also O’Neil (1986), pp.52–108, and ed. Stoy (1974), pp.63–65.
5. This enthralling topic – on the relationship between world-views and temporal paradigms – is explored thoroughly in Eliade (1989) and Eliade (1987).
6. Kramer (1988), pp.24–25.
7. The notion of ‘vertical time’ is well sifted through in Kramer (1988), pp.54–57, pp.210–211 & pp.375–397 (and *passim*).
8. For instance, over a human lifetime of seventy-two years, Earth’s north polar axis will have traced a mere 1° of arc (or thereabouts) along the circle of precession it ever so slowly describes in the heavens: the night sky will appear unchanged between one’s first and last viewings of it. Metaphorically, *all* durations appertaining to our human time-scale seem like the blink of an eye when contemplating inexorable, diuturnal stellar processes.
9. *Precession* is an astronomical term which according to David Baker – in Baker (1978), p.279 – signifies the “result of a coupled motion imparted to a spinning body which causes rotation around the axis of spin prescribing a cone in the process”. Earth’s slow precessional movement is much more comprehensively discussed within section 7.2.1 (endnote no.1b).
10. **Cycles of Vega**, Programme Annotation.
11. *ibid.*
12. The percussion parts in **Cycles of Vega** are composed almost entirely from such prefabricated cyclical rhythms, whereas its *e♭*-clarinet part is much less ‘systemic’, instead drawing upon a wider variety of materials, techniques and sources – including ‘borrowings’ (or even direct quotations) taken from **Cycles of Vega**’s companion piece, **Echoes/Fantasies**.
13. Samuel (1976), p.33.
14. For example, relative to the previous two subsections, one can apprehend various octave pitch-displacements together with additional embellishments within the *e♭*-clarinet part throughout

subsection C. This 'accumulative' technique therefore causes subsection C to be rather more complex and hectic for the $\text{e}\flat$ clarinet – which does accord well with the growing tension-levels during this region of the music.

15. (Bar 208 from **Cycles of Vega** is discussed within section 1.2.5.) As an intrusion upon the unfurling cyclicity here, it is begun with a gentle stroke upon the sizzle cymbal. In bar 209, the isorhythmic cycles resume, triggered again by the sizzle cymbal (which – to render the structural incursion even more patent – is not heard anywhere else within section three).
16. **Cycles of Vega**, Programme Annotation.
17. *ibid.*
18. Indeed, I now recall vaguely that I did adopt this particular compositional *modus operandi* towards percussion instrumentation – i.e. one of 'statistical timbral-set-constancy' – within all three sections from **Cycles of Vega**.
19. Their cyclicity, statistical distribution and weighting will be scrutinized within section 1.2.3.
20. Although I since revised **Cycles of Vega** by consigning *all* of its percussion music to *two* percussionists (thereby freeing the clarinettist's hands so that both of them could now act upon the $\text{e}\flat$ clarinet for the entire piece), I could find no compelling reason to change my original $\text{e}\flat$ -clarinet part in any way.

Essentially, **Cycles of Vega**'s revision was undertaken on account of sheer pragmatism: these days, alas, most clarinettists do seem quite reluctant to perform any composition wherein they might be required to play both upon their clarinet and upon some percussion instruments at the same time.
21. Aside from the many grace-note embroideries, only two of the $\text{e}\flat$ clarinet's pitches here are microtonally inflected (because quite a few of their fingering-configurations are standard).

SECTION 1.2.3

1. Moreover, within **153 Infinities**, the durations (in seconds) of the percussionists' bars – 1", 5", 8", 13", and 8" (at the beginnings of which they synchronize attacks) – all belong to the very well-known Fibonacci series. The sequence of Fibonacci numbers evinces some rather attractive mathematical properties; one of these properties in particular bears upon my compositional thought here:

The Fibonacci series is defined by the recursion formula $F_{n+2} = F_{n+1} + F_n$ (with $F_1 = F_2 = 1$), which thus yields an infinite set: $F = \{F_n\} = \{1, 1, 2, 3, 5, 8, 13, 21, 34, 55, 89, 144, \dots\}$. If we now design a new recursive sequence $R_{n+1} = F_{n+1} \div F_n$ based upon the ratios of successive Fibonacci numbers, then we can ascertain that as n becomes ever larger, so R_n becomes an increasingly better approximation of – and indeed, eventually converges upon – the venerable 'Golden Section' ratio, Φ : i.e. the limit as $n \rightarrow \infty$ of R_n is $\Phi = ((\sqrt{5} + 1) \div 2) \approx 1.6180339887$. So the bigger that n becomes, the more our Fibonacci series resembles a true 'geometric progression' whose common ratio is Φ . In other words, some of my relative bar-lengths here exhibit a kind of loose *diachronous proportional self-similarity*: $8:5 \approx 13:8 \approx \Phi$.

H. E. Huntley's treatise **The Divine Proportion: A Study in Mathematical Beauty** (1970) is devoted entirely to Φ and the Fibonacci series; significant portions of text within Jonathan Kramer's **The Time of Music: New Meanings, New Temporalities, New Listening Strategies** (1988) also discuss Φ and Fibonacci numbers as generators of *durational proportions*. Kramer (*ibid.*, p.305), furthermore, confirms the ubiquity of the Fibonacci series in nature and culture.
2. In section 1.2.5, I shall demonstrate that these subgamuts are in a proportionally self-similar relationship with respect to the system of gamuts within **Dimensiones Paradisi**.
3. **Dimensiones Paradisi**, Programme Annotation.
4. The concept of a 'trapdoor function' is well illustrated in John D. Barrow's wonderful book **Pi in the Sky: Counting, Thinking and Being** (1992), pp.150–154. See also Martin Gardner (1989).
5. Indeed, this same quality of 'unidirectional formativity' could rightfully be said to inhere in the gamuts themselves – particularly whenever a gamut's pitch-extremities are truly 'virtual', being nowhere articulated sonically.

SECTION 1.2.4

1. See Fideler (1993), pp.232–233.
2. Equally, such continuous segments may be *multiplied* to engender proportions: either procedure – multiplying or dividing by some constant – in the end yields identical ratios.
3. See section 1.2.5 for an analysis of the proportionalized pitch-gamuts within my alto flute solo **Dimensiones Paradisi**.
4. One is often able to synthesize particular proportional frequency-relationships amongst an electroacoustic timbre's spectral components. For instance, the carrier-to-modulator (c:m) ratios in Frequency Modulation sound-synthesis are basic timbral determinants that might also be employed to generate a piece's structural proportions at the sectional level. See Truax (1977) and Truax (1981).
5. Therefore, if the original span were from 0 to some other quantity β ($\beta \neq 1$), then after the proportions have all been computed within our 'normalized' unit-segment, one merely multiplies everything by β in order to ascertain the actual values.
6. Graham Pont: "Analogy in Music: Origins, Uses, Limitations"; in ed. Kassler (1991), p.198.
7. e is the base of the 'natural logarithms'; π is the circumference of a circle whose diameter is 1 unit; $\sqrt{2}$ is the length of the diagonal of a square whose sides are each 1 unit long; $\sqrt{3}$ is the height of an equilateral triangle whose sides are each 2 units long (and the length of the long diagonal of a cube whose sides are all 1 unit long). As such, these quantities positively resonate with meaning, and point to the elements of an 'idealized mandala' that contains all the basic geometrical and polygonal forms.
8. See, for example, Chadwick (1984), Fideler (1993), and Michell (1988).
9. Jesus Christ is explicitly characterized as *logos* in John 1:1.
10. This revolutionary idea is articulated clearly in Colossians 1:15–20.
11. Fideler (1993), pp.1–2.
12. *ibid.*, pp.59–60.
13. *ibid.*, pp.186–187.
14. Lawlor (1982), pp.4–5.
15. Schroeder (1991), p.xiii.
16. Alonso & Finn (1992), pp.956–957; Beiser (1962), pp.339–340; Margenau, Watson & Montgomery (1953), pp.745–746.
17. Alonso & Finn (1992), pp.955–998; Beiser (1962), p.370; Margenau, Watson & Montgomery (1953), pp.745–746.
18. Alonso & Finn (1992), pp.596–600 & pp.825–829; Beiser (1962), pp.357–364; Margenau, Watson & Montgomery (1953), pp.179–180 & pp.732–734.
19. Godwin (Vermont, U.S.A., 1987), pp.123–193.
20. Alonso & Finn (1992), pp.850–851; ed. Ridpath (1979), pp.27–28.
21. Theologically, this cosmic background radiation corresponds to *OM*, which Hindus claim to be the most primal vibration of the Universe; moreover, the Creative fiat repeatedly intoned through Genesis 1 – each being introduced by the formula "And God said, ..." – are purposeful, causative vibrations whereby things are 'spoken into existence' by the Almighty Logos.
22. The Hermetic thought of Robert Fludd is comprehensively mapped out in Joscelyn Godwin: **Robert Fludd: Hermetic Philosopher and Surveyor of Two Worlds** (1991).

23. Becker (1996), p.184 & pp.195–196.
Fideler (1993), p.236, adds that “[b]oth alchemy and Hermeticism are based on the premise that man encapsulates the forces which comprise the cosmos, an idea nicely summed up by the church father Origen (AD 185–254) who wrote ‘Understand that you are a second little world, and that the sun and the moon are within you, and also the stars’”.
24. Within the Christian tradition, the apostle Paul also (in I Corinthians 6:19 & 3:16–17 and II Corinthians 6:16) equates unequivocally the human form with a sacred temple. Jesus himself, though, is rather more ambiguous: in Matthew 26:61, Jesus is accused by the Pharisees of claiming that he is able to destroy the temple of God but then rebuild it in three days – referring not to the temple of stone in Jerusalem, but instead to the death and resurrection of his own body.
25. Lawlor (1982), p.90 & pp.92–93.
26. *ibid.*, p.91.
The entire chapter, titled **Anthropos**, from which these passages are quoted (*ibid.*, pp.90–95) is well worth reading on this arcane subject.
27. Godwin (Vermont, U.S.A., 1987), pp.17–18.
28. For instructive disquisitions on Fractal Geometry, consult Lauwerier (1991), Mandelbrot (1983), Schroeder (1991), and Stewart (1997); Gleick (1988), Jürgens, Peitgen & Saupe (1990), Mandelbrot (1990), Novak & Weber (1987), and Prigogine & Stengers (1984) are also quite informative regarding fractals.
29. This example is detailed at the end of section 1.2.11.1.
Furthermore, certain mathematical objects (such as the Fibonacci series) can be drawn upon to sculpt *approximations* of diachronous proportional self-similarity: see section 1.2.3 (endnote no.1) and section 1.2.11.2 for an explanation of Fibonacci numbers and their relationship to geometric progressions.
30. See section 1.2.12 for further remarks.
31. Toop (1979), p.96.
Regarding Karlheinz Stockhausen’s unification of musical time, I recommend that one read Clarke (1998), pp.222–225 and Decarsin (1998), pp.27–31. For ‘temporal analyses’ of specific pieces by Stockhausen, see also Decroupet & Ungeheuer (1998) and Misch (1998) – as well as that seminal article by Stockhausen himself, Stockhausen (1959).
Leonardi (1998), pp.64–65, opines that “... [Stockhausen’s] approach is similar to that of the Renaissance scholars, who sought to understand and to domesticate the chains that connect earth to heaven – the microcosm to the macrocosm – in an effort of mystical introspection doubled by a rigorous pursuit of knowledge and the things of the world. They conceived the universe as a whole, obeying very precise, secret laws, and in this way they ushered in the scientific rigor that was to follow. These laws are manifested in the connections between the infinitely small (the microcosm) and the infinitely large (the macrocosm); they were governed by the “discourse of resemblances”. God has covered the world with marks which serve to reveal hidden similarities between things. These marks can be read as one reads His word in the Scriptures and are accordingly bearers of truth. If God gave a seed the appearance of eyes, it is to let us know that it cures eye diseases [Foucault (1971), p.27]. If some plant or other has a part that looks like testicles, it is inevitably linked to seed, even if at the functional level it does not have a reproductive role. This is a logic that works at the level of language as well: similarities between words indicates hidden similarities between the things that they designate. Destiny may be read in the creases of the hand as well as in the stars. The plant is an animal that is living head down, and the connection that is maintained between grass and earth is the same as the one that is maintained between stars and sky. Things look like one another from one end of the universe to the other, without it being possible to say which is reality and which is mere appearance. All forms of comparison are legitimate. The favored point of comparison is Man: “Man’s body is always the possible half of a universal atlas”. In proportion with heaven, animals, and plants, “his flesh is a glebe, his bones are rocks, his veins great rivers, his bladder is the sea. . . .” [*ibid.*, p.22]. Each similarity leads to a new similarity, which could generate infinite series. It is then in order to give some limits to the discourse, “that we find that only too well-known category, the microcosm coming into play. This ancient notion was no doubt revived, during the Middle Ages and at the beginning of the Renaissance, by a certain neo-Platonist tradition. But by the sixteenth century it had come to play a fundamental role. . . . it applies the interplay of duplicated resemblances to all the realms of nature; it provides all investigation with an assurance that everything will find its mirror and its macrocosmic justification on

another and larger scale" [*ibid.*, pp.30–31]. Knowledge and asceticism can permit the rise of chains which connect the microcosm to the macrocosm, the road that sets out from the plurality of worldly things to attain the perfect unity of God. When Stockhausen invokes the notions of microcosm and macrocosm to explain his music, he makes in the end ideas that underlie all of Western culture come alive again. Despite having been supplanted by the rationalism of the eighteenth century they are still there, hidden, but close to our sensibility. ..."

32. Toop (1995), p.95.
Hughes (1991) and Toop (Summer 1991) further elucidate Chris Dench's compositional praxis.
33. **Lines of Light: Seven Improvisations on αιθερος μελος**, Programme Annotation.
34. Beiser (1962), p.355.
35. Margenau, Watson & Montgomery (1953), p.669.
36. *ibid.*, p.612; Bligh Bond & Lea (1977), pp.28–30; Harmsworth (2001).
37. Alonso & Finn (1992), pp.810–811; Beiser (1962), p.355.
38. For the table of letter-number equivalents in Greek *gematria* – as well as further discussion – see: Bligh Bond & Lea (1977), pp.5–10 & p.60 (and *passim*); Bullinger (1967), p.49 (and *passim*); Harrison (1994), pp.49–50 (and *passim*); Michell (1988), pp.59–60 (and *passim*).
39. For additional information about *gematria* involving the number 485 – as well as some of 485's geometric, symbolic and mathematical properties – read Bligh Bond & Lea (1977), pp.9–10, p.51 & pp.61–62.

Lea & Bligh Bond (1977), pp.125–126, also declares that "485 is a prominent Gnostic number. The Bruce Codex is full of it, and is indeed named after a mystic personage or formula – the Tetragrammaton IEOY = 485. He is Archon of the Aeon, and Bishop of the Light. And he is also the Man of Truth. 'Ο αληθης 'Ανθρωπος = 485. Now Seven times 485 = 3395 = ΦΩΣ ΕΚ ΦΩΤΟΣ – Light of Light, one of Our Lord's titles in the Nicene Creed. ..."
40. What, then, are the Sun's "semiotic overtones"? Udo Becker – in Becker (1996), pp.286–287 – writes that the "(apparent) revolution of the sun around the earth was one of the bases of the calendar, i.e., the year, since the beginnings of celestial observations. In astrology, the sun, like the Moon, is simply called "light". Among many peoples, it is one of the most important symbols; many primitive peoples and early civilizations worshipped it as a god; it is often represented as the visual embodiment of light and thus also of the highest cosmic intelligence, of warmth, of fire, and of the life-giving principle; its rising and setting, new each day, also made it a symbolic precursor of the resurrection [of Jesus] as well as of every new beginning in general. Because the sun shines upon all things with the same light and thereby makes them recognizable, it is also a symbol of justice. In Egypt, the sun enjoyed particular reverence; it was seen as the embodiment of the sun god Ra (occasionally in connection with or identified with other gods, such as Amun, Chnum, etc.); Ra had two sun ships with which he drove across the sky. Very common representations of the sun are the scarab with a sun sphere or an (often winged) sun disk with the uraeus serpent. Other sun gods include, for example, the Babylonian Shamash, the Greek Helios (with horses and sun chariots), the Roman Sol or the late Roman Sol invictus (meaning "the unconquered sun"). Often, such as among the Incas, in Egypt and in Japan, the sun cult was closely associated with the ruler cult. Other gods, although not actual sun gods, are often very closely related to the sun, such as Osiris or Apollo. The Indian Veda compares Brahma, the absolute, with the spiritual sun. In China, the sun (in contrast to the Moon) was regarded as a manifestation of the Yang principle ... Plato saw the sun as the visible representation of the good. In Christianity, Christ is often compared with the sun (such as in the phrase "sun of justice", which, in early Christian times, was also associated with the late Roman Sol invictus). Among most peoples, the juxtaposition sun-Moon corresponds to the poles masculine-feminine, yet there are also numerous known examples (such as in Central Asia or in German-speaking lands) having the reverse meaning (whereby the sun is a warming, nourishing, maternal principle). In alchemy, gold, which is also called "the sun of the earth", corresponds to the sun. Especially in hot lands, though, the sun can also appear in a negative sense as a principle of aridity and drought and thus as an adversary of the fertilizing rain. Some American Indian cultures also have the notion of a black sun, which is the sun that leaves this world during the night in order to shine in another one; it is a symbol of death and calamity and appears in representations on the back of the god of death or in the form of a jaguar, for example. In alchemy, the black sun is a symbol of the *prima materia*. One occasionally encounters a black sun in modern graphic arts and literature usually as a symbol of metaphysical angst or *melancholia*".

40b. Concerning the symbolism of 'light' in general, Udo Becker (*ibid.*, p.177) points out that it is an "omnipresent phenomenon that is well known to us in its effects but whose essence is largely unintelligible. It is thus a favored symbol of immateriality, spirit, and God as well as [of] life or happiness. One occasionally encounters a finer distinction between the light of the Sun, which symbolizes inspiration and spiritual vision, and the light of the Moon, which, as reflected light, symbolizes mediate forms of knowledge through rational, discursive thought. Light is frequently encountered as a border of darkness, which then usually appears as a symbol of ignorance and spiritual dullness, of morally underdeveloped or inferior areas and conditions, of death, misfortune or also of "mystery". In symbolic thought, the spatial notion of "up" and "down" ... corresponds to the relation between light and darkness. Nearly all fundamental principles based on a division of the world into a duality, refer to this distinction of light and darkness, such as Ormuzd and Ahriman, Yin and Yang, angels and demons, spirit and matter, masculine and feminine. The idea of an ascent from darkness to light plays an important role for many peoples with respect to the development of humanity as well as to that of the individual; numerous initiation rites are thus based on this duality. The separation of light and darkness as a postulate of the initial order at the beginning of the world is encountered in the cosmogonies of many peoples. Mystics sometimes speak of a darkness that lies "beyond" (rather than "beneath") the light of knowledge and that symbolizes the essential incomprehensibility of God. In the visual arts, the spiritual enlightenment of a person is frequently shown by an aureole, a nimbus, or a halo. ..."

41. Actually, this final "improvisation" outlaws *all* extemporizing, being fully, premeditatedly composed.

42. $740 = 37 \times 20$: therefore, by *gematria*, "Αἰθερος Μελος" is related through proportionality to the Divine Logos, Ἰησους Χριστος (Jesus Christ) = 2368 = 37×64 , and – more generally – to all of those expressions whose sum by *gematria* is some multiple of 37. Given the meaning of *logos* as 'ratio', the rôle of which is of course absolutely crucial in tempering music (ethereal or otherwise), I do find that such an outcome is particularly auspicious.

On the theological import of the number 37 itself, see section 1.2.5 (endnote no.15). Bligh Bond & Lea (1977), pp.65–73, also provides a table of "NAMES, EPITHETS, AND TYPES OF CHRIST, APPEARING IN THE GEMATRIA OF THE SACRED BOOKS AS MULTIPLES OF 37, TOGETHER WITH OTHER EXAMPLES". Within this table (*ibid.*, p.67), the number 740 is described as "... a cosmic number, being that of the ΚΥΚΛΟΣ – or Cycle, [and] of ΚΤΙΣΙΣ – Creation; [of] the ... ΙαΚΙΝ of the Hebrew temple symbolism, [of] the solar ΑΙΔΟΝΕΥΣ of Aegypto-Greek worship, [of] 'Η ΘΕΡΜΟΤΗΣ – Heat, [of] ΑΙΘΕΡΟΣ ΜΕΛΟΣ – The Music of the Spheres, and [of] the 'Ο ΕΠΙ ΠΑΣΙ ΘΕΟΣ [The God over All] of the Platonists". In their companion volume **Materials for the Study of The Apostolic Gnosis** – Lea & Bligh Bond (1977) – on p.38, it is also noted that "Plato is reported to have said that 'God geometrises' and his own name for God of Whose perfect form the Circle is his chosen symbol, is 'The God over All' – 'Ο ΕΠΙ ΠΑΣΙ ΘΕΟΣ. To understand this mystery one must go to the Gematria for an interpretation, and we shall find the interpretation on these lines, ready, perfect, and irresistible as evidence of the reality of the method even then existing. For the number of 'The God over All' is [$37 \times 20 = 740$,] the number of the Circle [ΚΥΚΛΟΣ], and both are the number of Creation ΚΤΙΣΙΣ. Now this number is not only one of a consistent geometrical series [i.e. the whole-number multiples of 37], ... but it is indissolubly linked with other numbers of the same series permeating the whole of the Greek text of the Septuagint and the New Testament alike; whence arises a strong argument for the continuity of the older and newer systems of Number-symbolism, Pagan and Christian. ..."

43. I omit mentioning several steps in the compositional process here, for they would only obscure matters – being extraneous to the topic at hand. (The whole issue concerning the genesis and fabrication of the seventh "improvisation" from **Lines of Light: Seven Improvisations on αιθερος μελος** is dealt with fully in Benjamin R. Loomes: **Gematria and Sacred Geometry in Lines of Light** by Ian Shanahan, BMus(Hons) Research Paper, Department of Music, The University of Sydney, July 1996, p.15.)

44. Those permutations from the cyclic group $\langle \mu \rangle$ that shuffle subsectional time-spans also serve a *symmetry-breaking* rôle: segmental rearrangement does subvert – albeit superficially – the otherwise rigid scalar invariance of proportional self-similarity.

44b. Concerning the *gematria* behind the Macrocosm-Microcosm – which *per se* irradiates all self-similarity with occult meaning – and its intimate relationship to those formative constants $\sqrt{2}$ and $\sqrt{3}$, Bligh Bond & Lea (1977), p.85, offer these rather beautiful insights:

"CABALA OF THE COSMOS. The Formative principles expressed by the mathematical powers One, Root Two, and Root Three, are assumed as the Aeons whose operation has been invoked to bring into manifestation the visible Universe. These may be said to determine the form of the Regular [i.e. Platonic] Solids and are hence fundamental. Taking as a plastic unit the 600 [which is the *gematria*] of κοσμος [cosmos], we discover in the Gematria of the Macrocosm and [of] the Microcosm the following very perfect example of this mode of interpretation.

(1) $600 \times 1 = 600$	600	ΚΟΣΜΟΣ [Cosmos].
(2) $600 \times \sqrt{2} = 848$ or 849		ΜΕΓΑΣ ΚΟΣΜΟΣ [Macrocosm] (848.5[3] actual value).
(3) $600 \times \sqrt{3} = 1040$ or 1039		ΜΙΚΡΟΣ ΚΟΣΜΟΣ [Microcosm] = 1040. (1039.23 actual.)
2488	2488	ΜΟΡΦΗ ΤΟΥ ΚΥΡΙΟΥ – The Form of God, which by Gematria is also ΙΗΣΟΥΣ ΚΥΡΙΟΣ ΚΟΣΜΟΥ – Jesus, Lord of the Universe[; and also] ΚΟΣΜΟΣ ΕΣΤΙ ΛΟΓΟΣ ΚΥΡΙΟΥ – ‘The Universe is the Word of God’.

Κοσμος [Cosmos] is the pattern as conceived in the Mind of God: *μεγας κοσμος* [macrocosm] its materialisation in space: whilst *μικρος κοσμος* [microcosm] is Man, its crown in whom the whole is reflected. And Man himself is created in the Image of God”.

Furthermore, it is perhaps worth commenting that even from a *mythological* perspective, the concept of Macrocosmic-Microcosmic self-similarity is innately ‘Musical’: in Classical Greek mythology, the mother of the Muses, Mnemosyne (whence the word ‘mnemonic’), is memory personified; yet around every point within a self-similar edifice, local data mnemonizes the whole. Self-similarity is therefore *mnémē* – memory – crystallized holographically.

45. Consult section 5.1.1 for an analysis of the harmonic morphology of **Lines of Light: Seven Improvisations on *αιθερος μελος***. (This composition’s ‘harmonic fields’, or pitch-reservoirs, are likewise rearranged by permutations from a cyclic group.)

SECTION 1.2.5

1. Within **A World of Becoming**, it will not prove necessary for me to define these procedures in a more rigorous sense using the symbology of mathematics. The following superb monographs – dedicated entirely to the engrossing subject of symmetry in nature and culture – do, however, provide such an exegesis: Simon L. Altmann: **Icons and Symmetries** (1992); Ian Stewart and Martin Golubitsky: **Fearful Symmetry: Is God a Geometer?** (1993); and the classic in this field by Hermann Weyl: **Symmetry** (1952). See also Stewart (1996), pp.85–106 and *passim*.

Manfred R. Schroeder – in Schroeder (1991), p.xiii – remarks that symmetry itself “is one of the most fundamental and fruitful concepts of human thought ... By symmetry we mean an *invariance* against change: something stays the same, in spite of some potentially consequential alteration. ... Nature built many of her organisms in nearly symmetric ways, and most fundamental laws of physics, such as Newton’s law of gravitation, [are isotropic, and thus] have an *exact* mirror symmetry: there is no difference between left and right in the attraction of heavenly (and most earthbound) bodies. ...”

2. Close (2000), pp.47–48: “... our Universe arose because it is quintessentially asymmetric. ... Indeed, asymmetry is seemingly necessary for anything ‘useful’ to exist. Many physicists now believe that the ultimate source of all asymmetric patterns may be traced back to a single event that took place within a split second of the big bang. ... A perfect Creation, with its symmetry untainted, would have led to matter and antimatter in perfect balance. The next instant would have seen a mutual annihilation as they recombined – in other words, a symmetrical Universe would have vanished as soon as it appeared. ... Mainstream cosmology has it that the Creation was barely completed before something interceded, and the perfection in which every atom of substance had been counterbalanced by a precise antipartner was lost forever. This broke the symmetry between matter and antimatter with the result that ... a small proportion was left over. Those remnants are what have formed us and everything around us. We are the material rump of what must have been an even grander Creation. ... A multitude of natural asymmetries have made the cosmos what it is. ...”
3. Stewart (1996), p.85.
4. John D. Barrow: **Pi in the Sky: Counting, Thinking and Being** (1992), pp.160–162.
5. Stewart (1996), p.97.
6. *ibid.*, pp.100–101.
7. *ibid.*, pp.101–102.
8. *ibid.*, p.111.
9. See *ibid.*, pp.109–113.

10. *ibid.*, pp.95–97: “Nature’s symmetries can be found on every scale, from the structure of subatomic particles to that of the entire universe. Many chemical molecules are symmetric. ... On a slightly larger scale than molecules, we find symmetries in cellular structure ... Viruses are often symmetric, too, the commonest shapes being helices and icosahedrons. ... Nature exhibits symmetries on larger scales, too. ... According to some cosmologists, the universe itself resembles nothing so much as a gigantic expanding ball. ...”
11. Weyl (1952), p.16.
12. *ibid.*, p.13.
13. **Solar Dust: Orbits and Spirals**, score, p.3.
14. **Dimensiones Paradisi**, Programme Annotation.
15. Theologically, this total of thirty-seven sections is deeply symbolic, the number 37 being a prime factor in the *gematria* of both ΙΗΣΟΥΣ (Jesus) = 888 = 37×24 , and his full title ΙΗΣΟΥΣ ΧΡΙΣΤΟΣ (Jesus Christ) = 2368 = 37×64 . (Paradoxically, the number of the Beast, 666, is also a multiple of 37.) According to Michell (1988), pp.61–62: “The prime number 37 was clearly of interest to the first Christians. Its most obvious numerological feature is that it generates the numbers in the series 111, 222, 333 etc., including the number of the Beast, 666 or 37×18 , and 888 the number of Jesus, who is also the Founder ο οικιστής, 888, and who further identified himself with that number by his claim, I am the Life, εἰμι ἡ ζωὴ, which has the value 888 or 37×24 . In their pioneer work on gematria early this century, F. Bligh Bond and T. S. Lea showed that many of the sacred names and phrases in New Testament and gnostic writings have numbers which are multiples of 37 [such expressions – written in Ancient Greek – have been compiled in Bligh Bond & Lea (1977) and Lea & Bligh Bond (1977)]. Subsequent research has turned up many further examples. Christ, Χριστός, has the number 1480 or 37×40 , and
1480 = Son of the Cosmos, υἱὸς κόσμου
holiness, ἡ ἀγιουσύνη
throne of wisdom, θρόνος σοφίας
the twelve pearls, οἱ δώδεκα μαργαρίται
Master and Lord (John 13:13), ὁ διδάσκαλος, ὁ κύριος
the Perfector (an epithet of Christ), τελεσφόρος
the hope of the kingdom of Jesus, ἡ ἐλπίς βασιλείας Ἰησοῦ
The number of Jesus Christ, 888 + 1480, is equal to 37×64 or 2368, and that number also pertains to διδαιουσύνη πίστεως, righteousness of faith (Romans 4:13) and to ὁ θεὸς τῶν θεῶν, the God of gods. In St John’s Gospel (15:1) Jesus announces his identity through gematria, saying, ‘I am the true vine, and my Father is the husbandman’. The true vine, ἡ ἀμπέλος ἡ ἀληθινή, 558, added to Father the husbandman, ὁ πατὴρ ὁ γεωργός, 1810, makes 2368, Jesus Christ”.
16. **Dimensiones Paradisi**, Performance Notes, p.i.
17. For the sake of secrecy – and also to preserve sanctity – I do not wish to divulge the precise mathematical formulae for these geometrically derived constants, which I will instead represent simply as decimal expansions. (Nor do I intend to harmonize my abbreviations for various geometrical figures [forthcoming] with particular shapes from within John Michell’s “New Jerusalem” diagram: for exactly the same reasons, I prefer not to label them explicitly.)
18. **Dimensiones Paradisi**, Programme Annotation – here quoting an English translation of the Gnostic poem **Thunder, Perfect Mind** (Nag Hammadi Codex VI.2, 4th century AD), 14:12–15.
19. On aesthetic grounds, and because **Dimensiones Paradisi** was originally composed for piccolo (the lowest [written] pitch of which is D₄3) but was later adapted to the wider-ranged alto flute, the pitches within these sections do not always conform strictly to my gamut-schemata – the basic principles of which were explained at the end of section 1.2.3.
- 19b. By specifying explicitly these mandala-polygons’ (and -circles’) *areas* and *perimeters*, their *shapes* are indeed *uniquely characterized* – assuming that they are ‘regular’ (i.e. all of their sides are identical in length). That is, for a regular polygon with *n* sides – let us henceforth call it an ‘*n*-gon’ – whose area is *A* while its perimeter is *P*, there will be one *and only one* whole-number value for *n* which satisfies all of these conditions.
Proof: Draw straight lines from the centre of an *n*-gon to each of its vertices. We can then see that our *n*-gon may be assembled from *n* identical isosceles triangles *T* with base-length $P \div n$, area $a = A \div n$,

and height h . Two of T 's angles are exactly the same, of course; its third angle is $(2 \times \pi \div n)$ radians. So:

$h = P \div (2 \times n \times \tan(\pi \div n))$, and therefore

$$a = h \times P \div (2 \times n) \\ = P^2 \div (4 \times n^2 \times \tan(\pi \div n)). \text{ Hence,}$$

$A = P^2 \div (4 \times n \times \tan(\pi \div n))$, and so we have established the relation R_n :

$$n \times \tan(\pi \div n) = P^2 \div (4 \times A), \text{ where } n \in \mathbb{N} \text{ and } n \geq 3.$$

Define $f(t) = t \times \tan(\pi \div t)$. Then the *first derivative* of $f(t)$ shall be:

$$f'(t) = \tan(\pi \div t) - \pi \times \sec^2(\pi \div t) \div t.$$

I claim that $f'(t) < 0$ for all $t \geq 3$, so that $f(t)$ is actually a *monotonically decreasing* function – in which case there can be just *one* value $t = n$ whereby $f(n) = P^2 \div (4 \times A)$, to satisfy R_n :

Now for all $k \in (0, 1]$ we have $\sin(k) < k$, so that, whenever $t \geq 3$:

$$\sin(2 \times \pi \div t) < 2 \times \pi \div t;$$

$$\sin(\pi \div t) \times \cos(\pi \div t) < \pi \div t;$$

$$\sin(\pi \div t) < \pi \times \sec(\pi \div t) \div t, \text{ and indeed}$$

$$\tan(\pi \div t) < \pi \times \sec^2(\pi \div t) \div t, \text{ thus proving conclusively that } f'(t) < 0 \text{ if } t \geq 3. \text{ QED}$$

But if the mandala-figure in question happens to be circular, then we may consider this circle to be an n -gon when $n \rightarrow \infty$. Note that by L'Hôpital's rule, the limit as $t \rightarrow \infty$ of $f(t)$ is π – viz. the line $g(t) = \pi$ is an asymptote of $f(t)$ – so that in R_n where $n \rightarrow \infty$, we obtain $\pi \equiv P^2 \div (4 \times A)$... which is truly the case for *all* circles yet, by the foregoing argument-by-calculus, is never possible for *any* n -gon wherever n is finite.

20. Beyond the asymmetry caused by sections G and H, any time-discrepancies between 'ideal' and 'actual' durations – such temporal 'errors' emanate, in the main, from the limitations of our (mensural) rhythmic notation-system – could also be regarded as disruptors of symmetry. Moreover, the tiny disparities between the actual time-spans of sections B and B' (ca.22.87" as opposed to ca.22.93"), and between those of sections C and C' (ca.27.62" by comparison with ca.27.55"), fracture the mirror-symmetry even more.
21. **Dimensiones Paradisi**, Performance Notes, p.i.
These three sectional categories – α , β and γ – parade rather dissimilar types of alto flute sonorities.
22. **Dimensiones Paradisi**, Programme Annotation.
23. **Dimensiones Paradisi**, Performance Notes, p.viii.
24. *ibid.*, p.ii.
25. Finally, within **Dimensiones Paradisi**, my schemata for breaking symmetries in general often prove to be self-similar when viewed acting within and across two or more architectonic tiers.

SECTION 1.2.6

1. These two works are cited in Cope (1984), p.310. Karlheinz Stockhausen's collection of 'text scores', **Aus den sieben Tagen** (1968), is discussed in Smith Brindle (1975), pp.96–98.
2. These observations could just as validly be made about *the titles of my compositions*. (Indeed, in the case of **Zodiac: Crystal Orbit Improvisations**, with the exception of its programme note the *only* 'poetic text' I have supplied anywhere within its score that immediately portends this work's ethereal Music-of-the-Spheres web of sound – not to mention its 'orbital' structural preoccupations – is its name.)
3. **Solar Dust: Orbits and Spirals**, score, p.1.
4. **Dimensiones Paradisi**, score, p.14.
5. **Cycles of Vega**, score, bar 213 (vibraphone).
6. *ibid.*, bar 180.

7. **Arcturus Timespace**, score, p.1.
8. **153 Infinities**, score, p.2 and *passim*.
9. *ibid.*, p.2.
10. **Dimensiones Paradisi**, score, p.1.
11. **Lines of Light: Seven Improvisations on αιθερος μελος**, score, p.1.
12. **153 Infinities**, each percussion part, p.1.
13. **Cycles of Vega**, score, bar 40.
14. *ibid.*, bar 208.
15. See section 1.2.11.1.
16. **153 Infinities**, score, p.5. (The “arithmetic series” here springs from a sequence of ‘triangular numbers’: 1; 1 + 2 = 3; 1 + 2 + 3 = 6; 1 + 2 + 3 + 4 = 10; etc.)
17. *ibid.*, p.2 & p.8.
18. **Dimensiones Paradisi**, Programme Annotation.
19. *Omphalos* (transliterated from the original Greek ομφαλος): Navel.
20. Becker (1996), p.210.
21. **Dimensiones Paradisi**, score, p.9.
22. **153 Infinities**, score, p.8.
23. Michell (1988), p.19 – quoting Dr Raphael Patai.
For a broader cultural overview of *omphaloi* in religion and sacred architecture, see Fideler (1993), pp.274–279 & pp.374–378 (and *passim*), and Humphrey & Vitebsky (1997), pp.140–143.
24. **Arc of Light**, score, p.1.
25. **[p]s(t)ellor/mnême**, Programme Annotation.
26. *ibid.*, score, p.1.
27. **Dimensiones Paradisi**, score, p.1, p.5, pp.6–7, p.9 (twice), p.10, p.12 & p.16.
28. Michell (1988), pp.33–42.
29. Becker (1996), pp.202–203.
See also Diana Brueton's book **Many Moons: The Myth and Magic, Fact and Fantasy Of Our Nearest Heavenly Body** (1991) for a more exhaustive study of the Moon's symbolism.
30. **Dimensiones Paradisi**, score, p.8 and *passim*.
31. *ibid.*, p.16.
32. *ibid.*, p.1.

My own personal interpretation of the image of Hermes is one dominated by the idea of a superior ‘winged Intelligence’ – a soaring, quicksilver ‘Mind’. This perspective of Hermes is apparently quite traditional, for according to Churton (1987), p.43: “... Hermes [was] ... the Greek god who, with wings on feet and wings on head (the mind) communicated between earth and heaven. ... as the messenger of the gods, [Hermes has] quick-footed movement ... His is the world of quick-thinking, the flashing insight of the *nous*, the higher reason, and his medium is spirit. This is the condition of mind in which

the Hermetic philosopher wishes to operate". Indeed, the often hyperactive sound-world of **Dimensiones Paradisi** does, for me, connote such a divine Hermetic 'celerity of thought'.

33. Becker (1996), p.194 & p.142.

34. **Dimensiones Paradisi**, score, p.3.

35. Becker (1996), p.195.

However, though its complementary passage of text for section α_1 might be considered just as evocative ("Somewhat diffuse and woolly: distant, impersonal, detached ... glossolalia! (In one breath...)" – **Dimensiones Paradisi**, score, p.14), this latter directive lacks such meaningful symbolisms.

36. **Dimensiones Paradisi**, score, p.16.

37. Godwin (Vermont, U.S.A., 1987), pp.123–193.

38. Notice that the music's details here clinch this symbolism. Emerging from the flute's C_4^3 fundamental (\approx 'Earth'), one hears in turn the next eight elements of C_4^3 's harmonic series: thus, each of these higher harmonics is matched with one of the eight celestial "spheres". (But even though D_4^6 , which corresponds to the ninth harmonic of C_4^3 , is not played literally as a 'harmonic' – i.e. the ninth mode of vibration – of C_4^3 , this stratospheric note's pitch, D_4^6 , undoubtedly conforms to this harmonic-series pattern. And being projected "with maximal purity!", its "pure!" timbre could indeed be evocative of the outermost, lustrous star-bearing "sphere".) Beyond the ' D_4^6 sphere', and having passed through the increasing nebulosity of random air-noise and whistletones, the flute sound then vanishes breathlessly into quiescent total silence at the end of section H (\approx 'Heaven').

My Programme Annotation for this work also insinuates an image of being Heaven-bound: "... there is a statistical tendency imposed upon the material of **Dimensiones Paradisi** to rise, inexorably, as if to Heaven...".

39. These Biblical verses are apropos: II Corinthians 12:2–4; Ephesians 4:10; Hebrews 4:14; and Hebrews 7:26. The 'three heavens' of Christianity here are 'earth', the 'night sky' (i.e. all of the stars and the extraterrestrial planets), and 'paradise' (i.e. 'Heaven' – beyond the other two 'lower heavens', wherein one basks in the nearby presence of God).

40. Churton (1987), p.44.

SECTION 1.2.7

1. **Cycles of Vega**, Performance Notes, p.v.

2. **Dimensiones Paradisi**, score, p.3.

3. **Zodiac: Crystal Orbit Improvisations**, Performance Notes, pp.iii–iv.

4. **Lines of Light: Seven Improvisations on αιθερος μελος**, Performance Notes, pp.iv–v.

5. **Zodiac: Crystal Orbit Improvisations**, Performance Notes, p.iv.

6. **Lines of Light: Seven Improvisations on αιθερος μελος**, Programme Annotation.

My 'chaos-to-order' metaphor here is not really legitimate in terms of *physics* (or Chaos Theory, entropy, or the Second Law of Thermodynamics); but I do believe that it *is* meaningful and poetic from the viewpoint of *human cognition*.

7. Informative primers on these abstract intellectual disciplines are Stewart (1997), Wilczek & Devine (1987), and ed. Carrigan & Trower (1990).

SECTION 1.2.8

1. **Lines of Light: Seven Improvisations on αιθερος μελος**, Performance Notes, pp.iii–iv.
2. **153 Infinities**, score, p.10.
3. **153 Infinities**, Performance Notes, pp.i–ii.
4. *ibid.*, pp.ii–iii.
5. **Cycles of Vega**, Performance Notes, p.v.
6. **Cycles of Vega**, score, bar 39.
7. **Zodiac: Crystal Orbit Improvisations**, Performance Notes, pp.i–ii.

SECTION 1.2.9

1. Within **A World of Becoming**, for example, the works of mine that showcase the recorder are **Five Études**, **Lines of Light: Seven Improvisations on αιθερος μελος**, **Zodiac: Crystal Orbit Improvisations**, and [p]s(t)ellor/mnême.
2. *Skins* (1985), p.234.
3. These three instruments form part of the battery of percussion found in **Cycles of Vega** and **153 Infinities**.
4. **Cycles of Vega** calls for two vibraslaps.
- 4b. “The vibra-slap”, according to Anon. (1996), “is a member of the extensive and ancient rattle family. Throughout its long history the rattle has been associated with ritual, dancing and protection against evil spirits. Today, as a popular member of the Latin-American dance orchestra, the vibra-slap still retains one of its ancient associations. The vibra-slap is 20th century in design, serving as a modern replacement for the ‘jawbone’ or *quijada* [which is the Spanish word meaning ‘jawbone’]. The jawbone, extremely popular with minstrel troupes in the USA during the first half of the 19th century, was originally an African instrument. It is, as its name suggests, the jawbone and teeth of an animal, traditionally a mule. Performers struck the open end of the jaw, causing the loose teeth to rattle and buzz. Some instruments had small bells attached for extra effect. In later years, teeth were detached and wired into the jaw to improve the rattle effect. As an instrument, the jawbone was highly prized – and for obvious reasons. In primitive society, beasts of burden were valuable and an animal could never be slaughtered simply to provide the material for a musical instrument. Bones were only obtainable by ‘natural wastage’. So the jawbone, as made from the jaw of a mule, was never readily available. Instruments constructed from the bones of other animals were, however, also used. The jawbone was imported into South America via the slave trade and from an early period became established in the folk music of [that] continent. In the early 20th century, when the fragility and scarcity of the jawbone was recognised, makers were encouraged to find a more robust and longer-lasting alternative that could produce a similar sound. The result of their experiments – the vibra-slap – proved an immediate and welcome addition to the Latin-American percussion band”.
5. **Arcturus Timespace**, **Cycles of Vega**, **Lines of Light: Seven Improvisations on αιθερος μελος**, and **153 Infinities** all employ windchimes.
6. Blades & Schechter (1985), pp.195–197: “... Rattle worship and the belief in the instrument’s magical power is widespread. It is an important item of the equipment used by the African witch doctor and his counterpart, the North and South American indigenous shamans. Rattles are used by Korean priests, and to Brazilians who indulged in rattle worship the rattle was the dwelling-place of the Devil. ... Early travellers to America found the rattle [to be] an important instrument in such ancient ceremonial dances as the *tupinamba* (ritual fire dance), and ceremonies connected with burial and sacrifice. ... Among the numerous elements used to make rattles, ancient and modern, are such macabre objects as human skulls filled with pebbles, and the jawbone of an ass or zebra in which the loose teeth act as rattling pieces. This instrument survives in the Latin American dance orchestra as the *quijada*, as do gourd rattles (maracas), and instruments such as the cabaca. ... Important types of rattle are the sistrum of the Middle East (used in much Eastern [and African] church music) and the Javanese *angklung*, a

bamboo rattle. ...”

Klaus P. Wachsmann – in ed. Baines (1961), pp.26–27 – also acknowledges the widespread belief that rattles or shakers are idiophones which possess numinous and apotropaic potency: “Rattles may serve to introduce the connexion between music and magic. They have often a magico-religious significance and are frequently part of the equipment of the witch doctor. In tropical South America the gourd rattle *maraca* is identified with the head of a supernatural being in whose service it is used. ... In the Middle Ages, lepers were compelled to carry [instruments such as rattles, scrapers, or clappers in order] to warn people of their presence – a protective function well in keeping with the magical powers attributed to [rattles] in tribal ritual, and foreshadowing their role as a gas warning [during World War I]. ...”

7. Metal percussion instruments are utilized in **Arcturus Timespace**, **Cycles of Vega**, **Lines of Light: Seven Improvisations on αιθερος μελος**, **153 Infinities**, and **[p]s(t)ellor/mnême**.
8. Becker (1996), pp.194–195.
For those who seek additional knowledge about such traditional planetary correspondences – and about celestial archetypes in general – consult Fidler (1993), pp.236–245 & pp.363–365 (and *passim*).
9. Becker (1996), p.283 & p.158.
10. In **Cycles of Vega**, **Lines of Light: Seven Improvisations on αιθερος μελος** and **153 Infinities**, the *rin* serve as highly resonant, lower-pitched timbral cognates of the *crotales* – although they are physically and acoustically quite distinct from them.
11. Kishibe (1984), Plate 40 shows a particularly large *rin* (known as a *dōbachi*) being struck by a Buddhist monk during a *Hōyō*. See also *ibid.*, pp.44–46.
12. Becker (1996), p.39.
13. Triangle windchimes are fastidiously deployed in **Cycles of Vega**, **Lines of Light: Seven Improvisations on αιθερος μελος**, and **153 Infinities**.
14. Becker (1996), p.298 & p.212.
15. *ibid.*, p.267.
16. *ibid.*, pp.308–309.
17. This latter interpretation is not at all out of place here, however. Although I do concede that I was entirely oblivious to this association whilst **[p]s(t)ellor/mnême** was being composed, I later realized that the waterphone represented perfectly my late father, Jim Shanahan (to whom this work was written *in memoriam*): he suffered from psychosis, stress disorders, and from many other ailments, as a direct consequence of the numerous extreme traumas inflicted upon him during World War II.
18. I have promoted the autocoil's very distinctive sound within **Cycles of Vega**, **Lines of Light: Seven Improvisations on αιθερος μελος**, and **153 Infinities**.
19. Becker (1996), p.277.
20. Brake drums are called for only in **153 Infinities** herein.
21. **Arcturus Timespace**, **Cosmos (One Note)**, **Lines of Light: Seven Improvisations on αιθερος μελος** and **Zodiac: Crystal Orbit Improvisations** all require electroacoustic sound-sources, either to be performed live in concert, or – as in **Arcturus Timespace** – to be played back from a pre-recorded medium.

SECTION 1.2.10

1. **Solar Dust: Orbits and Spirals**, Performance Notes, p.ii.
2. **Cycles of Vega**, Performance Notes, p.iii.

3. Similarly, my last verbal instruction in **Cycles of Vega** directs its performers to “Maintain your physical attitude for approximately 10 seconds: do not move until any other [percussion] resonances are lost in the distance. ... Now relax!”.

In live concert, such stases serve a theatrical as much as an acoustical purpose: in particular, I believe that the ‘special ambience’ of each of my compositions ought to be preserved for as long as possible before being shattered by an audience’s response to it ... at that moment when its players signal the work’s conclusion by relaxing.
4. **153 Infinities**, Performance Notes, p.ii.
5. **Zodiac: Crystal Orbit Improvisations**, Performance Notes, p.i.
6. **Dimensiones Paradisi**, score, p.16.
7. Becker (1996), p.48.
8. Within his foreword to that remarkable poem from the fourth-century Nag Hammadi Codices, **Thunder, Perfect Mind**, Douglas M. Parrott – ed. Robinson (1990), p.296 – states that: “The understanding of Perfect Mind appears to owe much to the Stoic notion of cosmic Pneuma, the active, intelligent element in all things, made up of air and fire. It was thought of as spanning all worldly divisions and dichotomies and at some level being responsible for everything that occurs. In its manifestation as reason, it was also able to instruct those who listen about the way to true life”.

SECTION 1.2.11

1. Steve Reich within his **Writings About Music** – in ed. Battcock (1981), p.152 – acknowledges such aural residua: “Even when all the cards are on the table and everyone hears what is gradually happening in a musical process, there are still enough mysteries to satisfy all. These mysteries are the impersonal, unintended, psychoacoustic by-products of the intended process. These might include submelodies heard within repeated melodic patterns, stereophonic effects due to listener location, slight irregularities in performance, harmonics, difference tones, ...”. In my own **153 Infinities**, however, certain mathematically patterned rhythmic “by-products” are by no means accidental, being quite premeditatedly composed.
2. **153 Infinities**, Performance Notes, p.iii.
3. Stockhausen (1959), p.13 & p.21.

Although he speaks of “logarithmic values” (*ibid.*, p.13), one ought to bear in mind, however, that Karlheinz Stockhausen in this essay is writing about sets of *chromatic durations* – i.e. *geometric* progressions of time-values which exploit the interval-ratio of an equal-tempered semitone ($^{12}\sqrt{2} \approx 1.059463094$, an irrational number) as their constant multiplier “t” – and certainly *not* about ‘logarithms’ as I have envisaged them within **A World of Becoming**. Notwithstanding, Stockhausen’s insights are equally apropos to this context.
4. Stockhausen (1959), p.33.
5. ed. Boretz & Cone (1976), p.22. (This passage is excerpted from an article by Kurt Stone that was first published in 1964: “Problems and Methods of Notation”.)

SECTION 1.2.11.1

1. Figurate numbers are perhaps better known – amongst mathematicians – as *polygonal numbers*. However, I myself do prefer the designation ‘figurate’ because it is, in fact, more accurate: strictly speaking, polygons are planar (i.e. two-dimensional), whereas there exist figurate numbers that correlate to polyhedra (three-dimensional, solid objects) and even to polytopes (the higher-dimensional counterparts of polyhedra and polygons).
2. John D. Barrow: **Pi in the Sky: Counting, Thinking and Being** (1992), p.42.

3. Mott-Smith (1954), pp.82–83.
4. Michell (1988), pp.49–51.
5. Becker (1996), pp.295–296: “[The Tetractys is the] sum of the numbers 1, 2, 3, 4 = 10. Among the Pythagoreans, it was a holy number, the quintessence of perfection; it was personified as the god of harmony. ... The number ten is the basis of the decimal system and is probably derived from the number of fingers on both hands. Even in antiquity, it was regarded as a sort of perfect number because it contains within itself all numbers between 1 and 9 ... For the Pythagoreans, the [Tetractys] 1 + 2 + 3 + 4 = 10 made 10 a divine and mysterious number that could also be represented as a figured number”.
6. These three classes of planar figurate numbers are: (i) vertex-centred; (ii) centred; and (iii) ‘spider’s web’. It is imperative to remember that whenever ‘figurate numbers’ are spoken of without any further qualification, they are always assumed to be of the *vertex-centred* variety (perhaps because this dot-constructive method seems more ‘natural’ than the others, and because it also ramifies into other domains of mathematics). So, the triangular numbers and square numbers which I have depicted thus far are all vertex-centred.

From my own library, my sources of information concerning figurate numbers in general were: Becker (1996), p.215; Harrison (1994), pp.349–350; Huntley (1970), pp.126–130; Mott-Smith (1954), pp.82–84; and Pickover (1997), p.47 & p.271.
7. Two analogous passages from my **153 Infinities** – one of which I shall analyse shortly – are ‘polygonal elaborations’ of Messiaen’s triangular-rhythmic artifice.
8. For in-depth – if sometimes wayward – expositions on ‘Biblical triangularity’ and Christian number-symbolism (a religious subject that one might pigeon-hole under ‘theomantics’), consult Harrison (1994) and Bullinger (1967); see also Becker (1996), pp.213–215 and *passim*. In **A World of Becoming**, though, the iconology of the triangular form and of ‘threeness’ has already been dealt with in section 1.2.9. It is, however, worth adding here that certainly, the very name of my **153 Infinities** (as well as its Programme Annotation) implies triangularity – since 153 is actually the seventeenth triangular number; such arithmetical significations are well supported by the many ‘triangular duration-sets’ within the music itself.
9. Becker (1996), p.278, p.122 & p.271.
10. For the sake of completeness, the third category of planar figurate numbers referred to earlier I have nicknamed ‘*spider’s web polygonal numbers*’; although they may well carry some other official nomenclature, nothing has come to light so far about them from the mathematical literature. ‘Spider’s web’ polygonal numbers are almost the same as centred polygonal numbers, with but a single distinction: here, the k th (r -gonal) figure’s perimeter will always consist of exactly r dots, for every $k \geq 2$. When its $k-1$ nested r -gons’ dots are connected perimetrically, and its $k \times r$ collinear dots which radiate out from the central dot are also joined, this figure then bears an uncanny resemblance to an r -gonal spider’s web!

The arithmetic behind ‘spider’s web’ polygonal numbers is quite uncomplicated:

 $a_{r,1} \equiv 1$ and for all $k \geq 2$, $a_{r,k} \equiv r$. So $\mathcal{A}_{r,k} = 1 + r \times k - 1$. Multiplying everything by a *chronos protos* d_1 , we deduce that (as before) $d_k = a_{r,k} \times d_1$ for $1 \leq k \leq n$, and so $s_n = \mathcal{A}_{r,n} \times d_1$. Therefore, whenever we want to begin with a given total time-span s_n , then:

 $d_1 = s_n \div (1 + r \times n - 1)$ and, for $2 \leq k \leq n$, $d_k \equiv r \times d_1 = r \times s_n \div (1 + r \times n - 1)$.

However, the reason why the theory of ‘spider’s web polygonal durations’ has been relegated to the endnotes is that they are by far the poorest musically: $n-1$ of their durations, d_2 to d_n , are all *absolutely identical*.
11. **153 Infinities**, score, p.9 & p.10.
12. *ibid.*, p.5
13. In (also written occasionally as \log_e) is the standard mathematical abbreviation for the ‘natural logarithm’ or ‘Napierian logarithm’ function, whose base is that omnipresent transcendental irrational number $e \approx 2.71828182845$.

SECTION 1.2.11.2

1. Kramer (1988), p.312.
2. *ibid.*, pp.297–303.
3. *ibid.*, p.289.
4. *ibid.*, p.290.
5. *ibid.*, p.298.
6. *ibid.*, pp.301–303.
Elsewhere (*ibid.*, pp.306–307), Kramer maintains that the geometric progression 2, 4, 8, 16 dwells within the time-structure of Béla Bartók's seminal piano piece **Allegro barbaro** (1911).
7. Kramer (1988), pp.303–304: "Theorists and analysts have been studying the use of the [Golden Section] ratio $[\Phi \approx] 1.62:1$ by composers as diverse as [Stockhausen, Feldman,] Barber, Hindemith, Schoenberg, Bartók, Webern, Berg, Prokofiev, Debussy, Ravel, Delius, Rachmaninoff, Fauré, Scriabin, Saint-Saëns, MacDowell, Dvorák, Wolf, Brahms, Wagner, Tchaikovsky, Schumann, Mendelssohn, Chopin, Schubert, Beethoven, Mozart, Haydn, [J. S.] Bach, Handel, Sermisy, Jannequin, Gibbons, Binchois, Dunstable, Ockeghem, Obrecht, Dufay, and Machaut".
8. For further details see Kramer (1988), pp.303–321.
9. *ibid.*, p.305.
10. Moreover, the geometric progression $\Phi, \Phi^2, \Phi^3, \dots, \Phi^k, \dots$ also evinces the following exquisite *additive* property: $\Phi^{k+1} = F_{k+1} \times \Phi + F_k$ for every $k \geq 1$.
11. Kramer (1988), p.305.
12. Nevertheless, I do acknowledge that beyond a certain threshold of temporal exiguity, I have been compelled to notate infinitesimal durations somewhat ambiguously, as grace-notes.
13. *Transcendental numbers*, like e and π , can never be a solution to any algebraic (or polynomial) equation $a_n x^n + a_{n-1} x^{n-1} + a_{n-2} x^{n-2} + \dots + a_k x^k + \dots + a_1 x + a_0 = 0$, where all of the coefficients a_k are integers and $a_0 \neq 0$.

SECTION 1.2.11.3

1. The base of the logarithm function here is utterly irrelevant, because the ratio $\log_a x : \log_a y$ will always be the same whatever the quantities of the positive real numbers x, y , and a (where $x, y, a \neq 0$ and $a \neq 1$).
Thus far, I have been unable to trace any compositional forerunners of logarithmic progressions of durations (as expounded herein) – although, as I have mentioned already, Karlheinz Stockhausen does talk about "logarithmic relationships" in his historically important essay**how time passes**..... (Stockhausen (1959), pp.11–13): but the term 'logarithm' therein is actually a misnomer.
2. This result is simply a corollary of the very definition of the logarithm function itself, since $\log (x \times y) = \log x + \log y$, and in general: $\log m_1 + \log m_2 + \dots + \log m_k = \log (m_1 \times m_2 \times \dots \times m_k)$.
3. In 1934, the Russian mathematician A. Gelfond proved that the quantity $\ln k$, for all integers $k \geq 2$, is a *transcendental number*. See Vygodsky (1975), p.302 n.1.
4. **Dimensiones Paradisi**, Performance Notes, p.i.
5. The exceptions are sections α_5, α_7 and α_8 (which do not engage with *any* 'logarithms'), and sections α_3 and α_4 (both of which incorporate *two* 'logarithms' – one for their multiphonics, and another for their remaining variegated sonorities and silences).

6. Section β_6 presents its logarithmic progression (of just three elements) in retrograde; section β_7 , which spans a little over a mere four seconds, parades only two multiple-tremolo fingerings whose relative durations frame the proportion $\log 2 : \log 3$.
7. Since any numerics behind my music often undergo several mathematical procedures, in order to minimize accumulative errors in my computations, I have generally retained the eccentric habit – really a vestige of my tertiary studies in pure mathematics during the early 1980s – of expressing quantities to many decimal places (usually with nine or ten significant figures); my sketches are riddled with such punctiliousnesses, and so I preserve them herein.

SECTION 1.2.12

1. For **Arcturus Timespace**, the actual equations behind its tempo-glissandi have all been lost from my surviving sketch-materials – although one such formula does turn out to be very easily reconstructible. However, I do still have in my possession a dozen or so hitherto unpublished sheets containing all of the types of tempo-glissando formulae I analysed, their workings and proofs; but most of these details are far too mathematically convolute to reproduce herein. (Rather, I proffer these papers – in facsimile – as Appendix 9 of **A World of Becoming**.)
2. ed. Boretz & Cone (1976), p.69. (This quote is taken from an article by John MacIvor Perkins which was first published in 1965: “Note Values”.)
3. There are occasional anomalies: some tempo-values in **Cycles of Vega** were interpolated at a later date by estimation (instead of calculation); these were then written into the score manuscript. Such discrepant indications shall be pinpointed later, within the appropriate tempo-glissando tables.
4. In **Cycles of Vega**, the tempo-glissandi have been coupled with matching contours of dynamic levels: gradients of tension are thereby reinforced through a careful deployment of dynamic indications in conjunction with the tempo-glissandi; there clearly exists a sharp correlation between dynamic levels and metronome markings. For instance, a long-range *diminuendo* corresponds with the gradual *rallentando* between bars 12 and 36. Throughout bars 40–85, where the tempo remains steady, a low dynamic level predominates. Between bars 86 and 178, dynamic levels rise incrementally – supporting the *accelerando* – which reaches its peak at bars 175–177, where the tension is extremely high and the dynamics are now at the loudest end of the phon scale. (Notice that the *e♭*-clarinet’s figurations here significantly enhance the sense of excitement by including rapid grace-note flourishes, flutters, trills, and finally a wailing altissimo pitch modulated by key-vibrato.) *Mutatis mutandis*, a protracted *diminuendo* conforms to the work’s final *decelerando* in bars 180–214.

For both **Echoes/Fantasies** and **Cycles of Vega**, fluctuating *vibraphone vibrato-rates* similarly meld with tempo-glissandi to further influence the evolution of tension within these works – although it is quite probable that such a subtle technical gambit impacts upon tensional contours only subliminally.

5. **Cycles of Vega**, Performance Notes, p.ii.
Such practice is not required by the soloist for **Arcturus Timespace**, since its tempo-glissandi already inhere immutably within its pre-recorded electroacoustic part.
6. All of the relevant results are substantiated within Appendix 9.
One class of tempo-glissando equations that were inspected by me during the early 1980s – namely, T expressed as a function of whole-number powers of hyperbolic sines and hyperbolic cosines in b – I shall omit altogether from this present discussion, on the grounds of their sheer complexity. (See Appendix 9, pp.A 34–35 for their details.)
7. Within my own private notes, I have worked out all of these formulae up to and including the case $n = 4$. They are duplicated in Appendix 9, pp.A 30–33.
8. John MacIvor Perkins, *op. cit.*, p.69 n.13.
See also Boretz & Cone (1976), pp.14–15, where, fortuitously, this particular musical passage from Elliott Carter’s score is reproduced.
9. The case of $r = 1$ yields T as a linear function of b, a tempo-formula which has already been inspected. (Moreover, when $r = 0.5$, we reap the ‘gravitational equation’ for T as a function of b, explored initially.)

10. In this equation for $T(b)$, if we find its limit as $r \rightarrow \pm\infty$, then we discover that $T(b)$ converges uniformly to our equal-tempered tempo-scale formula: $T = T(b) = T_0 \times (T_B \div T_0)^{(b \div B)}$. (For proof of this assertion, see Appendix 9, p.A 39.)
11. The equation for the tempo-glissando from section B through to section E in **Cycles of Vega** has alas been lost – if it ever had been written down within my sketch-materials in the first place. I am unable to recoup it: all that can be said about it now is that it is certainly non-linear (with respect to b), and it might even be a member of this infinitely abundant class of tempo-glissandi, but with some other value for r (besides $r = -0.75$).

CHAPTER 2. ENTERING THE SOUND-WORLDS OF THE MANDOLIN AND FM SYNTHESIS

2.1 ARCTURUS TIMESPACE

2.1.1 BRIEF ANALYTICAL NOTES

Prelude

I conceived **Arcturus Timespace** in terms of both organized sound *and* visual images – “... projections [which] optionally accompany [my] music ... consist of diverse stars, star systems, nebulae, galaxies, luminous gas-clouds and -sheets...”,¹ as well as background lighting – but it may well best be classified as an example of *multimedia* (a combination of art-forms)² in which sound dominates, so that omitting this piece’s discretionary visuality does not necessarily entail an artistic failure. Its projected images certainly do reinforce my music in various ways, with the spectacle of live performance itself contributing likewise to the work’s ‘cosmic aura’; and yet I always intended, *ab initio*, that the music of **Arcturus Timespace** could function successfully alone, without *any* auxiliary visuals in concert.

Arcturus Timespace’s visual projections also serve to conjure up an ‘artificial environment’, with its own temporality; locally, they tend to melt from one shot to the next at a rate corresponding approximately to the music’s pace, so that this work’s acoustic and visual media do fortify one another (without the latter – or, for that matter, the soloist’s theatricality – distracting alert listeners). However, the metamorphic images never ‘Mickey-mouse’ my music in any way – neither medium is slavishly in lock-step with the other – nor, I believe, is there ever any ‘information overload’ wherein an excess of sensory data forces one to digest only a single facet of my composition. **Arcturus Timespace** is, furthermore, able to succeed artistically without explicit visual components precisely because its music is vivid enough to stimulate audience members to spontaneously devise their own *implicit* images.

What might the generic compositional relationships (if any) between **Arcturus Timespace**’s instrumental and electroacoustic forces be? I continually pictured a triangularity of sorts – mandolin ↔ percussion ↔ ‘tape’ ↔ mandolin ↔ ... – whereby

[the] percussion instruments ..., all played by the soloist, form a kind of ‘sonic bridge’ [mediating] between the mandolin and the electroacoustic part. They include: various types of glass fruit-bowl or ceramic flowerpot-like objects (eight “clay bells”); a

collection of six Korean stainless-steel mixing bowls; shell-disc, ceramic-disc, and brass-tube windchimes; and a large tam-tam.³

Arcturus Timespace's electroacoustic part (which was synthesized entirely by using Frequency Modulation algorithms) fills out my instrumental textures, and comprises

[a] *mélange* of computer timbres [that] are mostly bell-like, possessing a glassy, metallic, or ceramic sheen (modelled to some extent upon the acoustical signatures of the percussion instruments themselves). ... In composing **Arcturus Timespace**, my intention ... was to have the electroacoustic part intermingle with, yet also extend, the sounds of the mandolin and percussion.⁴

And I also came to think increasingly of the soloist's mandolin as a variety of 'plucked bell', in order to assimilate it somehow with this work's other assorted sound-sources.⁵ I realized, too, that certain of the mandolin's pitch-bends were rather evocative of the Japanese *kōtō* – indeed, the playing technique I have in mind is identical for both of these instruments: one exerts pressure upon the string(s) behind its bridge or *ji* – although such a cross-cultural association only occurred to me just prior to the completion of **Arcturus Timespace**. (In any case, I strove at all times to sidestep the cliché of mandolin-as-Italianate-icon.) And yet with this piece there was very little conscious effort on my part to connote *any* nation's music: I did try to maintain the quixotic fiction of commencing with a cultural *tabula rasa* ... and clearly failed, because the tam-tam throughout **Arcturus Timespace** (as within so many Asian musics) was deliberately utilized as a structural marker, as a colotomic beacon that demarcates subsections.

If anything, though, I do sense in this work an influence more of Asian *aesthetics* than of Eastern compositional or instrumental performance techniques.⁶ In live concert, for example, **Arcturus Timespace**'s instrumental array as well as its soloist's supplicatory posture and gestuality – e.g. his kneeling: a "sign of deference, humility and subordination"⁷ – perhaps insinuates some Buddhist ritual (despite the fact that the soloist's playing position was arrived at in close collaboration with **Arcturus Timespace**'s commissioner, Stephen Morey, purely through the consideration of performative practicabilities).

Arcturus Timespace: Its Music's Macrostructure

... [O]n a technical level, the structure of **Arcturus Timespace** is basically cyclical. After an extended introduction by the soloist, the pre-recorded electroacoustic part repeats itself in a strict manner after approximately two minutes. Superimposed upon this, however, the soloist's part is 'through-composed', with hints of recursion over a shorter periodicity – so that the apparent 'orbits', of the human performer's music playing against its electroacoustic accompaniment, do not coincide. A mosaic formal design, a clockwork-like mechanism reminiscent of the workings of the Cosmos itself, thus unfolds; it extends upon that of an earlier work, **Echoes/Fantasies** (1984), to

which some of the musical material of **Arcturus Timespace** is related. (Moreover, such abstract concepts stem, to some degree, from my involvement with chess problems: the art of chess composition is capable of insinuating all sorts of unique musical forms, structures and ideas!) The closing section of **Arcturus Timespace** also invokes this same metaphorical ‘orrery process’ from Celestial Mechanics, only compressed into a somewhat more compact time-frame.⁸

To some extent, the improvisatory ambience of **Arcturus Timespace** is quite intentional: its cyclical processes do act subliminally upon listeners, to generate a spacious, resonant ‘feel’ – one suggestive of freedom at play. Nonetheless, this composition is rather tightly structured.

Arcturus Timespace fleshes out the following form-outline:

INTRODUCTION: bars 1–12 (letter A to letter B); ♩ = ca.35.

a) the soloist

Non-systemic material: sustained e♭s with microtonal intonations from the percussion instruments (bars 1–5), which are then extended and developed (bars 5–12). The tam-tam (bar 11 – *mp*) signals a closure colotomically, before a brief cadential ‘codetta’ (bars 11–12).

b) the ‘tape’ part

tacet.

MAIN SECTION: bars 12–102 (letter B to letter E); ♩ = ca.40, with an extended *accelerando* (i.e. a continuous tempo-glissando) between bar 42 (letter C) and bar 102 (letter E).

a) the soloist

Non-systemic and rather pointillistic material, yet with some motivic development. The tam-tam (which undergoes its own *crescendo*) is again colotomic, partitioning the main section into five subsections at twenty-bar intervals: bar 31 – *p*; bar 51 – *mp*; bar 71 – *mf*; bar 91 – *f*; and bar 102 – *p*. Aside from the fifth and shortest subsection, the others are all of approximately the same length:

Subsection:	1	2	3	4	5
Span (in ♩s):	68.5♩	72.5♩	70.5♩	65♩	37.5♩

b) the ‘tape’ part

Three layers of systematically permuted durations are interwoven, to produce an isorhythm that is thirty bars long; it is played three times in all – bars 12–42 (letter B to letter C), bars 42–72 (letter C to letter D), and bars 72–102 (letter D to letter E). Each occurrence of this isorhythm comprises its own self-contained ‘subsection’; the isorhythmic repeats, moreover, do accrete small amounts of additional material.

LINKING PASSAGE: bars 102–113 (letter E to letter F); ♩ = ca.80, *rallentando* (to ♩ = ca.40, at bar 113).

a) the soloist

The colotomic tam-tam flags the start of this short transitional passage, in which the soloist – who gently rests their mandolin on the floor – is mostly dormant.

b) the ‘tape’ part

The first seven bars of the main section’s isorhythm are again repeated here, prior to moving on to new material that acts as a bridge into the next section.

CLOSING SECTION: bars 113–135 (letter F to letter H); ♪ = ca.40.

This final, microcosmic section replicates some of the processes of the main section, but on a smaller time-scale – ‘self-similarly’.

a) the soloist

After the soloist has remained quite still (until bar 116), a two-bar pulseless *isomelos* (written in a variety of time-space notation) emerges out of the electroacoustic texture; it is played about twelve times in all – the number of repetitions is actually rather free – including an ‘incursion’ by the three windchimes (at bar 126), which emulate the electroacoustic sounds.⁹

From bar 130 (letter G) onwards, this *isomelos* begins to fracture and dissipate into complete silence and stillness at bar 135 (letter H); in doing so, it makes use of percussion instruments not previously employed in the *isomelos*.

Note that the soloist’s music throughout this closing section is never strictly synchronized with its electroacoustic accompaniment.

b) the ‘tape’ part

The electroacoustic part here is a type of ‘virtual windchime’ that embraces six strata of cyclic material – all having the same digital FM ‘voice’ – where every time-cycle spans its own unique duration. A protracted fade-out, starting at bar 120, reaches silence before bar 130 (letter G).

As with **Cycles of Vega**, the repetitive time-cycles in **Arcturus Timespace** – some of which unfurl concurrently, but with different periodicities – could be regarded as sonic models of our Cosmos: **Arcturus Timespace**’s morphology thereby possesses symbolic meaning. Certain aspects of this composition’s cyclical structure shall now be elucidated in somewhat more detail:

The Electroacoustic Part’s Isorhythmic Structure for bars 12–42, bars 42–72, and bars 72–102

Pitches within this ‘computer isorhythm’ were settled upon instinctively – as were my choices of FM timbres and their orderings. At times, though, the ‘tape’ pitches deliberately match those elicited from **Arcturus Timespace**’s percussion instruments – such as in the first three bars of this isorhythm, the ‘seed’-material and permutational structure of which is absolutely identical to that of an earlier work of mine, **Echoes/Fantasies** (1984) for bass clarinet and percussion. How was this particular isorhythm composed? Its ‘seed’ or basis-rhythm, R, consists of twenty-eight durations:

R’s ordinal numbers:	1	2	3	4	5	6	7	8	9	10
their durations: *	6.333 ♪	4.667 ♪	2.5 ♪	3.5 ♪	1.5 ♪	1 ♪	8.5 ♪	2.4 ♪	1.6 ♪	6 ♪
R’s ordinal numbers:	11	12	13	14	15	16	17	18	19	20
their durations: *	1 ♪	1 ♪	1 ♪	1.5 ♪	10 ♪	1.5 ♪	0.667 ♪	9.333 ♪	9 ♪	3 ♪
R’s ordinal numbers:	21	22	23	24	25	26	27	28		
their durations: *	1.5 ♪	2 ♪	2.5 ♪	2 ♪	3 ♪	2 ♪	4.5 ♪	11.5 ♪		

* NB: some ‘irrational’ durations’ values herein – i.e. each of those time-spans involving triplets – have been rounded off to three decimal places.

R was then permuted by Ψ , where

$\Psi = (10) (8, 9) (1, 2, 17, 18) (6, 15, 20, 25, 24, 26, 19) (3, 11, 16, 23, 28, 5, 12, 27, 7, 14, 22, 4, 13, 21)$.

As was stated above, both $R \equiv \Psi^0$ and its permutation Ψ were abstracted from **Echoes/Fantasies** without any alterations whatsoever. And yet – aside from an outward kinship of sound-worlds which might suggest that both of these pieces could have been penned by the same composer – I admit that this constructional bond between my **Arcturus Timespace** and **Echoes/Fantasies** is most likely not consciously recognizable (nor was it ever meant to be). In any case, to formulate this isorhythm, I selected three duration-sets from the 28-member cyclic group $\langle \Psi \rangle - R, \Psi^3$, and Ψ^6 – thence straticulated them, their entries being staggered canonically so that the isorhythm itself begins with duration number 22 from R. Likewise, this rhythmic polyphony is probably inaudible as such: its ever-shifting timbres do militate against any perception of ‘line’, and so my three conflated rhythms will instead tend to be heard more as a single durational trajectory that generates **Arcturus Timespace**’s electroacoustic texture throughout this section.

One final, but crucial, point: Due to a limitation in the software¹⁰ I employed (to sequence **Arcturus Timespace**’s electroacoustic music) concerning its TUNE command – used in this work for effectuating microtonal deviations away from equal-tempered semitones – any ‘on-paper’ simultaneities were compulsorily arpeggiated. The *rates* of such chordal arpeggiations do vary markedly, and tend to distort my temporal schemata somewhat – quite considerably on occasion – while nevertheless precipitating a textural subtlety and complexity that more than counterbalances any processual ambiguities.

The Closing Section’s Electroacoustic Part (bars 113–130)

For the closing section of my **Arcturus Timespace**, its electroacoustic part comprises six tiers of repetitive time-cycles (all of them projecting the same FM ‘voice’). Each tier gyrates through some extremely complex – but in fact casually constructed – rhythms that do sound quite ‘beatless’, yet fall into strictly metrical structures. Their isorhythms’ lengths are all different from one another, with most being practically incommensurable:

Tier	Isorhythmic Lengths and their Number of Cycles	Total Duration
1.	8 ♪ × 10 + (4 ♪)-rest	84 ♪
2.	8.75 ♪ × 9	78.75 ♪
3.	4.5 ♪ × 18	81 ♪
4.	7.5 ♪ × 11	82.5 ♪
5.	9 ♪ × 9	81 ♪
6.	8.25 ♪ × 10	82.5 ♪

Before **Arcturus Timespace**'s stereo electroacoustic part was finally mixed onto tape, the output from the two Yamaha CX5M music computers for each duration in every tier was already set at 'left channel alone' [L], 'right channel alone' [R], or 'both channels' [C – for 'centre']. Within all of the six tiers, consecutive tones are made to cycle through space: L → C → R ...; R → C → L ...; C → L → R ...; R → L → C ...; C → R → L ...; or L → R → C Such *spatial* cyclicity interlocks, and even fuses together, the strata of this six-layer polyphony.

The isomelodic pitches of this 'electroacoustical orrery' spring from a playfully woven 12-tone row (and its inversion), all of whose tones have been subjected to a random microtonal inflection of up to a quartertone. (Their intonations all remain constant as each *isomelos* is repeated.) This 12-tone row of mine, whose pitch-classes are arrayed below, displays some curiously symmetric combinatorial properties – as is indicated by the array's arrows; such a fortuitous palindromicity eventuates, I imagine, because of the predominance of tritones within the row's prime form:

Note:	1	2	3	4	5	6	7	8	9	10	11	12
P_0 :	C \flat	F \sharp	G \flat	C \sharp	B \flat	F \flat	E \flat	D \flat	G \sharp	E \flat	B \flat	A \flat
I_0 :	C \flat	F \sharp	F \flat	B \flat	C \sharp	G \flat	A \flat	B \flat	E \flat	G \sharp	D \flat	E \flat

I then chose the pitches to inhabit each tier simply by cycling continuously through *both* of these fundamental row-forms – I_0 to P_0 to I_0 , and so forth:

Tier	Pitch-Classes	Pitch Sources – I_0 and P_0
1.	C \flat F \sharp F \flat B \flat C \sharp	I_0 , notes 1–5
2.	G \flat A \flat B \flat E \flat	I_0 , notes 6–9
3.	G \sharp D \flat E \flat C \flat F \sharp G \flat C \sharp B \flat	I_0 , notes 10–12; P_0 , notes 1–5
4.	F \flat E \flat D \flat G \sharp E \flat B \flat A \flat	P_0 , notes 6–12
5.	C \flat F \sharp F \flat B \flat C \sharp G \flat A \flat B \flat	I_0 , notes 1–8
6.	E \flat G \sharp D \flat E \flat C \flat F \sharp G \flat C \sharp B \flat	I_0 , notes 9–12; P_0 , notes 1–5

The length of every tier's pitch-sequence above corresponds to the number of durations within its isorhythm. Furthermore, the octave-register of most pitches within these *isomeloi*, though basically selected at random, is either high or very high – thus rendering my cyclic 'wheels-within-wheels' process rather opaque. (Certain lower tones, however, do occasionally pop out of the volatile texture, to hint at its inherent cyclicity.)

Although **Arcturus Timespace**'s electroacoustic music has been painstakingly structured, for this work's closing section I intended a somewhat arbitrary effect (rather like

a windchime),¹¹ but with a covert repetitiveness and cyclicity which might induce a feeling of 'levitating timelessness' amongst listeners. Indeed, its continuity and ethereal soundscape evokes for me the idea of 'cosmic melody' (as with a signal being sent or received by some radio telescope, or humankind broadcasting messages of friendship into the unknown vastness of outer space).

ENDNOTES

1. **Arcturus Timespace**, Programme Annotation.
2. For more ideas regarding what exactly constitutes 'multimedia', read Cope (1984), pp.209–214 (and *passim*).
3. **Arcturus Timespace**, Programme Annotation.
4. *ibid*.
5. Statistically, around 50% of the soloist's part within **Arcturus Timespace** has been expressly allocated to the mandolin – although the Compact Disc recording of this piece might not give one that impression.
6. Within my Programme Annotation to **Arcturus Timespace**, "I also state, for the musicological record, that any perceived association between my soundscape in this piece and the musics of Asia is entirely coincidental!".
7. Becker (1996), p.166.
8. **Arcturus Timespace**, Programme Annotation.
9. A piquant paradox: the windchimes' sounds – by nature acoustically stochastic and statistical – are superficially related to this mercurial electroacoustic texture, which is constructed quite formulaically.
10. viz. "Yamaha FM Music Composer II", operating on two Yamaha CX5M music computers.
11. My desire to invoke some sense of 'statistical randomness' here was the principal motivation behind my dispassionate construction of P₀.

Ian Shanahan (1987 / 1994)

– *To Ian Fredericks*

For Stephen Morey to play:

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# *Arcturus Timespace*

for

soloist (amplified mandolin, percussion) and ‘tape’,

with

*optional* light- and image-projection

~~~~~

PROGRAMME ANNOTATION

Arcturus Timespace

for soloist (amplified mandolin, percussion) and 'tape',
with optional light- and image-projection

Ian Shanahan (1987/1994)

Le silence éternel des espaces infinis m'effraie.

– Blaise Pascal.

Pascal's wonderful aphorism – “The eternal silence of infinite space terrifies me” – evokes certain images which **Arcturus Timespace** attempts to capture. Truly, I have been spellbound by astronomy, cosmology, and the Cosmos itself since I was a child – and even now, I am constantly awed when I look up at the clear night sky with all of its breathtaking beauty, brilliance and grandeur, savouring the realization that I am peering through both ‘infinite’ space *and* time. Is it therefore not surprising that (as a composer and as a human being) I am really not concerned with the deification of music history and the attendant compositional supplication before musical idols of the past, with petty nationalisms and benighted tribal mentalities, with grubby politics and all that is mundane ... but more with the mystical and the sacramental, spirituality, new technologies, and – in particular – with the limitless extension of sonic and artistic possibilities? I am a musician who looks primarily to the future, and the future of Mankind is *out there*.

So, on a technical level, the structure of **Arcturus Timespace** is basically cyclical. After an extended introduction by the soloist, the pre-recorded electroacoustic part repeats itself in a strict manner after approximately two minutes. Superimposed upon this, however, the soloist's part is ‘through-composed’, with hints of recursion over a shorter periodicity – so that the apparent ‘orbits’, of the human performer's music playing against its electroacoustic accompaniment, do not coincide. A mosaic formal design, a clockwork-like mechanism reminiscent of the workings of the Cosmos itself, thus unfolds; it extends upon that of an earlier work, **Echoes/Fantasies** (1984), to which some of the musical material of **Arcturus Timespace** is related. (Moreover, such abstract concepts stem, to some degree, from my involvement with chess problems: the art of chess composition is capable of insinuating all sorts of unique musical forms, structures and ideas!) The closing section of **Arcturus Timespace** also invokes this same metaphorical ‘orrery process’ from Celestial Mechanics, only compressed into a somewhat more compact time-frame.

The stereophonic ‘tape’ part of **Arcturus Timespace** was realized at the Sydney University Experimental Sound Studio, directed by Ian Fredericks; being computer-generated, it utilizes the Frequency Modulation Algorithmic Sound Synthesis techniques of two Yamaha CX5M music computers. The *mélange* of computer timbres are mostly bell-like, possessing a glassy, metallic, or ceramic sheen (modelled to some extent upon the acoustical signatures of the percussion instruments themselves). Although I do confess that this timbral world is in danger of becoming an ‘FM cliché’ ... I just love bell sounds!

In composing **Arcturus Timespace**, my intention *ab initio* was to have the electroacoustic part intermingle with, yet also extend, the sounds of the mandolin and percussion. (I also state, for the musicological record, that any perceived association between my soundscape in this piece and the musics of Asia is entirely coincidental!)

The percussion instruments employed in **Arcturus Timespace**, all played by the soloist, form a kind of ‘sonic bridge’ between the mandolin and the electroacoustic part. They include: various types of glass fruit-bowl or ceramic flowerpot-like objects (eight “clay bells”); a collection of six Korean stainless-steel mixing bowls; shell-disc, ceramic-disc, and brass-tube windchimes; and a large tam-tam.

The image projections that optionally accompany the music of **Arcturus Timespace** consist of diverse stars, star systems, nebulae, galaxies, luminous gas-clouds and -sheets... It is perhaps also worth mentioning that the amplified mandolin's output, as well as that of the electroacoustic ‘tape’ part, are both spatially controlled through a mixing desk during live performance.

Arcturus Timespace is gratefully dedicated to Ian Fredericks and Stephen Morey.

© Ian Shanahan, Sydney, Australia; 14 April 1987.

Arcturus Timespace, commissioned by Stephen Morey and the ensemble ELISION, was premièred by Stephen Morey (amplified mandolin and percussion) and Ian Shanahan (sound diffusion), during an ELISION concert – “Madness in Paradise – The Return” – held at the Sandy Beach Community Centre, cnr. Beach Road & Sims Street, Sandringham, Melbourne, on 26 April 1987.

A recording of **Arcturus Timespace**, played by Stephen Morey, is now commercially available on the Compact Disc “Solar Dust” (Broad Music Records Jade JAD CD 1080).

PERFORMANCE NOTES

PREAMBLE

I wish to thank *Stephen Morey* for his research assistance, for his kindness in demystifying the subtleties of the mandolin for me, and for his patient editorial guidance later on in the compositional process of **Arcturus Timespace**. Moreover, this piece could never have sprung into existence without the constantly warm, avuncular guidance of the late *Ian Fredericks*, who (at the very last minute) even helped me to carry out the final mix-down of **Arcturus Timespace**'s electroacoustic part. I am also greatly indebted to my dear friend *Steve Clark* for his expert desktop-publishing of my score using FINALE 2000. I thank all of these gentlemen for their affable generosity.

1. GENERAL REMARKS

INSTRUMENTATIONAL REQUIREMENTS

• **Amplified Mandolin and Percussion (1 player)**

- 1 mandolin (preferably flat-backed)
- 2 tuning forks: A440 Hz and A415 Hz
- 8 clay (or glass) 'bells'
- 6 Korean stainless-steel mixing-bowls
- 1 large tam-tam {suspended in a frame}
- 3 windchimes
 - 1 brass-tube windchime
 - 1 shell-disc windchime
 - 1 ceramic-disc windchime

Note: technical specifications with detailed descriptions of these instruments shall be given later; I have also appended to these Performance Notes a comprehensive diagram and a photograph depicting their *physical layout and appearance*.

• **The Electroacoustic 'Tape' Part**

My stereophonic 'tape' part to **Arcturus Timespace** was composed – from December 1986 to March 1987 – at the Sydney University Experimental Sound Studio [SUESS], then directed by Dr Ian Fredericks. Being computer-generated, it utilizes the Frequency Modulation Algorithmic Sound Synthesis techniques of two Yamaha CX5M music computers. A CD copy (or the *.wav file) of this 'tape' part is available from the Australian Music Centre [AMC] {website: <<http://www.amcoz.com.au>>} or directly from the composer {postal address: 57 Yates Avenue, Dundas Valley NSW 2117, AUSTRALIA}; it can also be purchased together with the score from the AMC. Note that in live performance (due to a 'bug' in the computer programming?) the tempi may be slightly faster than notated.

AMPLIFICATION OF THE MANDOLIN AND THE PERCUSSION INSTRUMENTS

It is necessary to amplify the mandolin, preferably with a high-quality omnidirectional condenser microphone placed fairly close to the instrument. Likewise, several microphones will undoubtedly be needed to reinforce the delicate sounds emanating from the 'bells' and mixing-bowls in particular.

GRACE-NOTE GROUPS

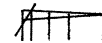
Grace-notes occupy (very) short indeterminate duration – which I leave to the discretion

~ j ~

of the soloist. In general, they should be played somewhat rapidly (but not necessarily evenly) – at a speed to an extent dependent upon local context and other instructions or technical exigencies – up to 'as fast as possible'. Nuances of grace-note speed have also been denoted by the number of *beams* (one, two, or three) that span the grace-note group, by accompanying verbal directives, and even by *tenuti*. Furthermore, grace-notes ought not to be thought of as mere 'ornaments', of secondary architectonic status, to the 'main notes': *all* sonorities in **Arcturus Timespace** are equally important!



– an *accelerando* within the grace-note grouping.



– a *rallentando* within the grace-note grouping.

PAUSES

Unless otherwise indicated, precise durational details of pauses are left to the interpretation of the soloist. The following non-traditional symbology is employed:



is a *squared fermata*, denoting a *relatively lengthy pause* (increasing a duration by at least a factor of 2.5). Whenever this symbol appears within the stave the duration of the pause is always specified above the stave (in seconds).

TIME-SPACE NOTATION (BARS 116–134)

For these bars, the space between each 'ictus' (short, thick vertical stroke) corresponds to one ♩ at metronome 40 = 1.5 seconds. Within this temporal grid, play any musical events between such ictuses *approximately* in direct chronometric proportion to their relative horizontal placement upon the score-page. Any sense of metricated rigidity is strongly discouraged! (Temporal *asymmetry* ought to be strived for.) Sustained or connected durations herein are notated with extended beams.

DYNAMIC INDICATIONS

Apart from the usual dynamic indications (*ppp*, *pp*, *p*, *mp*, *mf*, *f*, *ff*, *fff*), the following symbols are employed in **Arcturus Timespace**:

p poss. and *f poss.* are abbreviations for 'as soft as possible (but still audible)' and 'as loud as possible', respectively;

Dynamic indications apply until they are modified by the next dynamic instruction. Moreover, a proper balance of dynamics between instruments ought to be maintained throughout **Arcturus Timespace**: for example, the perceived loudness of an *mf* sonority in one part should match that within other parts. (Since amplification levels are controlled ultimately by the sound-projectionist, however, dynamic indications can never be absolute but simply represent what the soloist attempts.

ARTICULATION AND RESONANCE

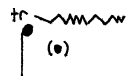
All articulations – *legato*, *tenuto*, *mezzo-staccato*, *staccato*, *staccatissimo*, *accent* (>), *sforzando* (^) etc. – should be duly observed. A *sforzando* attack will always be based upon the prevailing dynamic level, so that (for example) *sffz* = *sforzando* in *ff*. Moreover, *all* instrumental sounds must be allowed to resonate *for as long as possible* – often to extinction. But whenever the soloist moves from their mandolin to the percussion instruments, the mandolin sound's resonance-time is notated explicitly.

~ ii ~

PITCH DESIGNATION

In any textual references to pitch herein “Middle C” shall be designated as C₄3, the C₄ one octave higher as C₄4, etc. (i.e. assuming that A₄3 = 440 Hz, then C₄3 ≈ 261.6255653 Hz). Small degrees of intonational deviation – slight microtonal inflections, of up to about a fifteenth – upwards and downwards are indicated by upward-pointing and downward-pointing arrowheads, respectively, upon accidental symbols.

TRILLS



denotes a *trill*. The pitch of the secondary note(s) is indicated by a small notehead in parentheses; note that the interval between trill-pitches may be greater than a major 2nd, so that the expression ‘trill’ herein refers to an oscillatory trilling-action over *any* interval! The evolution in velocity of a trill’s motion is denoted by changes in the moment-to-moment frequency of the triangular waveform contour.

CUEING THE PROJECTIONISTS (BARS 12 & 132)

All personnel must agree upon cueing signals before bringing **Arcturus Timespace** to a public performance: such signals from the soloist should be quite subtle (certainly not so blatant as to inform the audience!) – merely a glance, or some other unobvious ritualistic gesture.

2. THE MANDOLIN: DETAILS

CHARACTERISTICS OF THE MANDOLIN, AND STAGE SET-UP

Arcturus Timespace assumes a normal mandolin (of flat-back design, preferably)[†] possessing at least 19 frets. For maximum visual impact during live performance, the soloist’s music stand(s) should be set *as low as possible* and, if necessary, encompass a small, unobtrusive yet reliable *light* (such as a ‘book light’ – purchasable from large department stores) to illuminate their sheet music. Furthermore, it may well prove necessary to suspend the mandolin from the soloist’s neck using a strap, sling, or even an efficacious length of string!

[†] Since the soloist kneels on the ground (upon a cushion or pillow) surrounded by percussion instruments throughout their performance of **Arcturus Timespace**, a flat-back – as opposed to a Neapolitan – mandolin is definitely preferred here, because from bar 113 onwards this instrument, too, must be deposited upon the floor: a round-back Neapolitan mandolin in such a deployment would tend to be rather unstable, and so may need some kind of cradle apparatus to prevent it from rocking back and forth.

OPTIONAL ‘WORKING OF THE MICROPHONE’

A denotes some (optional) movement of the mandolin *away* from the microphone.

M denotes some (optional) movement of the mandolin *closer* to the microphone.

M - - - - **A** denotes a continuous (optional) *change of distance* between the mandolin and the microphone, as indicated. The dotted line defines the moment in time when such a transition begins; precise details of execution are otherwise left to the discretion of the soloist.

TUNING OF THE OPEN STRINGS

One string on each course of the mandolin is to be very slightly lowered in pitch, thereby producing a richer basic timbre: a ‘chorus effect’. The resultant beat-frequencies should be no greater than 4 – 5 Hz (beats-per-second) on the open strings, with different beat-frequencies being generated upon each (open) course; precise details are left to the discretion of the soloist.

SPECIFICATION OF COURSES

The course to be played upon at any given moment is indicated in the usual manner: G, D, A, E (each letter being ringed within the score). When such a symbol is omitted, either the musical context renders the choice of course obvious, or a whole sequence of notes is to be played upon the same course as specified at the beginning of the sequence.



ACCIDENTALS


Any accidental within the score of **Arcturus Timespace** applies only to that note which it immediately precedes.


ARTICULATION AND RESONANCE


All strings on the mandolin must be permitted to ring on *as much as possible*. Noteheads marked with a small tie ‘to nothing’ (i.e. a ‘lasciare vibrare’) are to be left to resonate beyond their given durations.


The following symbology applies especially to articulation:


  – *tenuto* (hold the note for the full duration as given, or even a little longer) and *staccatissimo* (very short, *molto staccato*), respectively. These symbols do *not* imply the application of any additional accent or stress, unless otherwise indicated.

 – pluck only the first note and *hammer* or *pull-off* the subsequent notes with the left-hand fingers, according to the melodic contour.

 – *legato*: pluck only the first note, but for the subsequent notes, merely *place* or *lift* left-hand fingers on or off the fingerboard, according to the melodic contour.

 – *snap pizzicato*: lift the strings with the thumb, or thumb and forefinger, and allow them to snap back percussively against the mandolin’s fingerboard.



 – pluck only *one string within the course*. (This directive applies to single notes only.) Unless this symbol is given, the number of strings per course that are to be plucked is left to the discretion of the soloist.

 – *arpeggiate* the notes in a somewhat leisurely manner.

 – *strum* (i.e. *rapidly arpeggiate*) the notes of the chord.


For both forms of *arpeggiation*, their speed of execution is left to the interpretation of the soloist. *Arrowheads* upon the above symbols indicate the *direction* of the arpeggio’s action: ↑ = play the *lowest-pitched* course first; ↓ = play the *highest-pitched* course first.

PLUCKING MATERIAL

-  – pluck the string(s) with a *plectrum*. The point or the side (i.e. rounded edge) of the plectrum may be used at the discretion of the soloist.
-  – pluck the string(s) with the *right-hand index finger* or (*thumb*). The *pad* or the *tip* of the finger may be used at the discretion of the soloist.

Note: The specified plucking material is to be employed until the other is called for. Moreover, from bar 116 onwards, the mandolin's open strings are also occasionally strummed with the very end of a vibraphone mallet's rattan/cane handle!






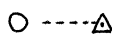
TREMOLO

-  – a *tremolo* (successive up- and down-strokes) is to be executed very quickly or as quickly as possible (tastefully, according to the musical context).


When playing *tremoli* with a *plectrum*, the *side* (i.e. rounded edge) of the plectrum may be used in soft dynamic levels to impart a more gentle, slightly fuzzier quality than is usually obtained by using the plectrum's point. Furthermore, in tremolo, a *diminuendo* to *very low dynamic levels* may be achieved by gradually rotating the flat face of the plectrum through 90° relative to the length of the string. When playing *soft tremoli* with the *finger*, the *finger tip* may be utilized instead of the pad in order to achieve a different subdued quality. All of these techniques may be used at the discretion of the soloist.

PLUCKING POSITION

The following symbols are mostly affixed to the relevant note's *stem* – except in the case of plucking-position *transitions* in tremolo, when they are drawn *beyond the notehead*:

-  – *molto sul ponticello*: pluck the string(s) *very close* to the bridge indeed.
-  – *sul ponticello*: pluck the string(s) *close* to the bridge.
-  – the normal plucking position (abbreviation: *pos. ord.*) is notated in the usual fashion.
-  – *sul tasto*: pluck the string(s) 'up the neck' somewhat (on or towards the fingerboard), nearer to the middle of the vibrating string-length than usual.
-  – *molto sul tasto*: pluck *precisely* at the middle of the vibrating length of the string(s) – directly above the twelfth fret for the open string(s), or directly above the fret which is twelve frets higher than that fret where the finger stops the string: this plucking position may actually be beyond the end of the fingerboard. Plucking the string(s) *molto sul tasto* will yield a timbre that is very mellow, rich in odd-numbered harmonics.
-  – *in tremolo only*, a smooth transition of plucking position (as indicated). The dotted line defines the moment in time when the transition begins; precise details of execution are otherwise left to the discretion of the soloist.

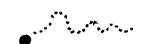
ACTIVATING THE STRINGS BEHIND THE BRIDGE

-  – activate the strings *behind the bridge*. All eight strings must be activated, and they should be permitted to ring on, unimpeded. In bar 134, the direction and speed of arpeggiation is indicated in conjunction with this symbol.

The two *tuning forks* listed earlier (one at A440 Hz and the other at A415 Hz [≈ G# 3 relative to A440]) are required in bars 111–112: the eight strings behind the bridge of the mandolin are to be struck *as forcibly as possible* with the tuning forks' tines, after which their butts are immediately to be placed upon the bridge itself – to yield a gentle and sustained semitonal 'hum'.


PITCH-BENDING AND VIBRATO TECHNIQUES

Just one type of *pitch-bend* and *vibrato* is employed throughout **Arcturus Timespace**. Vibrato is generated simply through the repeated application of a pitch-bend technique.


-  – *kōtō* vibrato/pitch-bend: according to the given contour, depress and release the string(s) *behind the bridge* with the right-hand index finger (and/or other right-hand fingers), causing the pitch to fluctuate above the written note.

The waveform contours provide only an *approximate* indication of the frequency and amplitude of the required actions. The maximum amplitude of the given contour should correspond directly to the maximum pitch-bend physically attainable in the musical context.

PORTAMENTO


-  – *portamento*: slide the left-hand finger(s) along the fingerboard from one position to another, thereby allowing the pitch to (smoothly) rise or fall, as indicated. The *speed* of the sliding action is carried out according to the notated duration. *Articulation* – 'legato': *do not* pluck the terminal note of the portamento; or 'tenuto': conduct the sliding action and then pluck the terminal note of the portamento – is always indicated in conjunction with these symbols.

NATURAL HARMONICS

-  – on the specified open string(s), lightly touch the *node* (with a left-hand finger) at or near the fret corresponding to the pitch notated with a broken-diamond notehead, while plucking ... in order to produce the harmonic sound. Harmonics must always be allowed to ring on.

Specific *plucking positions* for harmonics are rarely requested herein, so as to encourage the soloist themselves to locate a plucking position that furnishes the *cleanest, most sonorous timbral quality* for each harmonic. (Occasionally, however, technical and physical constraints may restrict the ambit of choice for a harmonic's plucking position.) **Note:** Resultant pitches of harmonics are nowhere displayed within the score itself.

BITONES

-  – on the specified course, stop the strings normally at the fret corresponding to the pitch notated with an oblong notehead, and pluck the strings between the stopping

finger and the *nut*! (It is generally easier and more successful to pluck the strings somewhat away from the stopping finger.)

The following bitone – shown with its projected resultant pitch (which is not given within the score itself) – has been utilized in **Arcturus Timespace**, bars 38–39:

Course	Fingered pitch	Resultant bitone pitch
A \natural 3	G \natural 4	C \sharp 5

Note: Because mandolins' actions can vary from one instrument to another, the resultant bitone pitch in practice might not correspond exactly to that predicted within the table above. Regardless of inaccuracies, however large (or small) any bitone pitch-discrepancy might be, the soloist whenever performing this bitone is *on no account ever* to attempt to 'correct' such deviation – should it occur – by selecting some other course or fret to stop: only that course and conjunct fingered pitch specified above may be engaged for the production of this bitone in **Arcturus Timespace**.


3. THE PERCUSSION INSTRUMENTS: DETAILS

INTRODUCTION

Arcturus Timespace calls for some unusual and exotic percussion instruments. Therefore, so as not to make this piece's realization prohibitively difficult, certain substitutions are permissible. It is, however, crucial that the tunings of the percussion instruments described below be preserved *at all costs*: these particular intonations were very much in my 'mind's ear' throughout the composition of **Arcturus Timespace**. Hence it is obligatory that instruments which conform as closely as possible to these tunings be procured! Note that certain percussion instruments whose pitches *almost* match those designated may in fact be inflected accordingly: for example, some mixing-bowl pitches could be flattened somewhat by pouring a certain amount of water into them (although the water's inertia could entail an undesirable loss of resonance).

RESONANCE AND ARTICULATION

Please permit all percussion sonorities to *resonate beyond their specified durations*: such sounds should actually be allowed to ring on until they have completely dissipated. Furthermore, when playing percussion 'chords' – simultaneous attacks upon two percussion instruments – it is *not* crucial that the attacks must coincide with absolute precision: indeed, slight differences in attack-onset (to yield a very rapid arpeggio) might even be musically desirable!

 denotes a *sweeping motion* of a mallet across the sides of two adjacent 'bells' (bar 13).


TRILLS ON THE 'BELLS'


All trills between a pair of clay (or glass) 'bells' are to be executed with just one hand, by rattling a single mallet between two horizontally adjacent instruments.


MALLETS

The following pictographs illustrate the different types of percussion mallet called for in **Arcturus Timespace**. Drawn together *within rectangular boxes*, such pictographs show the number and type of mallets required throughout each section of the music; no more than one mallet per hand is ever needed. A *non-boxed mallet pictograph* refers just to a

specific instrument and single event or note.

 denotes a *yarn-wound vibraphone mallet of medium hardness*.

 Invert the vibraphone mallet and play the designated instrument(s) with the very end of the vibraphone mallet's rattan/cane handle (bars 96, and 116 onwards!)

 denotes a *large, (very) soft tam-tam beater*. This tam-tam beater should be carefully suspended from the tam-tam's frame in such a way that the beater's interference with (damping of) the tam-tam's resonance, after the tam-tam has been struck, is non-existent or negligible.

PERCUSSION INSTRUMENTS: DETAILED DESCRIPTIONS AND ABBREVIATIONS

Within the percussion staves, the percussion instruments have been notated in sequential order according to their physical distribution; they are listed below in the same fashion.

8 Clay (or Glass) 'Bells': Clays *

These gently percussive sound-sources may be fictile or ceramic flowerpot-like objects, vitreous fruit-bowls, basins, or other glass vessels (and so forth). Their intonations and other acoustical characteristics are:

Instrument	Main Pitch(es)	Other Partials	Modulation
1	G \sharp 5	C \natural 7	fast vibrato
2	F \sharp 5	A \sharp 6	medium vibrato
3	D \natural 5	G \natural 6	slow vibrato
4	A \natural 4, C \natural 5	E \natural 6	—
5	G \natural 4	C \natural 6	fast vibrato
6	F \sharp 4	D \sharp 4, B \natural 5	—
7	E \flat 4	A \flat 5	medium vibrato
8	B \flat 4	D \natural 5	slow vibrato

Attack transients and higher partials do tend to be softer, and attenuate rather more quickly, than the lower, main pitches. Note too that instrument number 6 has a metallic 'chatter' with several high partials – due to some sort of manufacturing flaw – whenever it is struck hard.

6 Korean Stainless-Steel Mixing-Bowls: Steels *

If such lovely metal sound-sources are unobtainable, then appropriately tuned gongs, Japanese temple bells (*rin*), or some other metallic found-objects with suitably lengthy decay-times will certainly make satisfactory substitutes. Their intonations and other acoustical characteristics are:

Instrument	Main Pitch	Hum Tone	Other Partials	Modulation
1	A \natural 4	E \flat 3	G \flat 5	—
2	F \natural 4	B \flat 2	D \flat 5	slow vibrato
3	B \flat 3	E \natural 2	A \flat 4	medium vibrato
4	B \flat 3	E \flat 2	A \flat 4	slow vibrato
5	D \natural 3	G \natural 1	C \sharp 4 (nasal)	medium vibrato
6	A \flat 2	D \flat 1	G \natural 2, (D \natural 4)	medium vib., nasal

* Whenever the clay (or glass) 'bells' or the stainless-steel mixing-bowls are struck forcibly, there is a real danger that they may be toppled over. Such a catastrophe can be prevented simply by

attaching lozenges of "Blutac", "Bostik", "Plasticine", or some other malleable gummy substance to the base of each instrument – thereby physically attaching it to the floor. However, instrumental resonances absolutely must not be interfered with!

1 Large Tam-Tam: T-T

A large, resonant tam-tam (at least 1300 mm in diameter, if possible) – very deep, profound and mysterious! Strike the tam-tam in its usual, slightly off-centre beating-spot.

3 Windchimes: Wch †

1 Brass-Tube Windchime: BrTW

This metallic windchime consists of ten or so small thick brass tubes (outer diameter ca.6 mm, maximum length ca.120 mm), sounding within the range C \sharp 6 — C \sharp 7: brilliant, starry, cutting, high-pitched; ca.10-15" decay. If necessary, randomly-chosen rods from a Mark Tree may be hung in a circle as a substitute for this windchime.

1 Shell-Disc Windchime: ShW

This 'crustaceous' windchime consists of many large discs made of shell, suspended vertically in several lines. It should possess a 'hard' moderately loud clattery sound – medium- to high-pitched; ca.5" decay.

1 Ceramic-Disc Windchime: CW

This earthenware windchime consists of six to ten large glazed ceramic discs, which may be irregularly shaped. It should possess a rich and resonant sound – 'loud', mellow, relatively low-pitched; ca.15-20" decay.

† Agitate the elements of these windchimes directly, with hand(s) or mallet(s), roughly in accord with the notated waveform contours.

4. STAGE SET-UP, BACKGROUND LIGHTING AND IMAGE-PROJECTION – IN CONCERT

Through performative experience, I do believe that the most practical set-up for playing **Arcturus Timespace** requires the soloist to *kneel on the stage-floor or a dais* (with their knees resting upon a cushion or pillow, for comfort) surrounded by the percussion instruments, which themselves repose upon the same flat surface; a diagram and a photograph depicting this work's instrumental array are appended to these Performance Notes.

It is critical, too, that the gestural/theatrical aspect inherent within my instrumental set-up and the public presentation of **Arcturus Timespace** must *enhance* its music, not impede or contradict it. All physical gestures and actions carried out by the soloist must be seen to be deliberate, fluid, and totally controlled: this sort of 'effortless theatricality' is crucial, for instance, in the transition passage where the mandolin is placed upon the ground then struck with tuning forks (bars 109–112). Furthermore, the soloist should always pick up mallets as discreetly and unobtrusively as possible.

LIGHT- AND IMAGE-PROJECTION: DETAILS

Arcturus Timespace was conceived such that it ought to be a successful artistic opus whenever it is presented in a regular concert-hall venue as a *purely acoustical composition*: thus, my proposed light- and image-projections are both *optional* 'extras'. If, however, such projections are to be used in concert, then I would encourage an imaginative approach to set-design: semi-transparent 'sculptures', such as white tent-flies, might act as backdrops (behind the soloist's instruments) against which the images will be projected – so that they could instead function more as complex, somewhat ambiguous light-projections rather than as clear, distinct images. In any case, background lighting and

the images themselves must, at the very least, encompass an area including the soloist and their instruments.

Light-projection (i.e. background lighting), if employed at all, calls for just two colours – a deep blue, and an intense red – which are able to be cross-faded and dimmed to blackness: from bar 48, the deep blue lighting ever so gradually changes to red as the piece nears its climax (around bar 92), returning once again to deep blue (at bar 113) before fading into total darkness (during bar 135). The 'preliminaries', before the work proper starts, do, however, require careful treatment:

After the auditorium's house-lights have all been dimmed to complete darkness prior to the very beginning of **Arcturus Timespace**, the soloist moves quickly, silently, and furtively into playing position – their shoes having already been removed (as if one were entering some sacred space!). Once the soloist is settled in place, remaining perfectly still, the deep blue background lighting and the first astral image are then slowly faded-in (approximately together). A few seconds after the background lighting and initial projected image have achieved their full brightness, the soloist – as instructed by the score on p.1 – then picks up their mandolin and begins to play...

As my Programme Annotation to **Arcturus Timespace** attests, its *projected images* "consist of diverse stars, star systems, nebulae, galaxies, luminous gas-clouds and -sheets...". The sixteen slides used during **Arcturus Timespace**'s première performance have all been digitally archived – their source-photographs were scanned at high resolution (506 dpi) and then saved as JPEG or TIFF files, at most 9 MB in size – and I am happy to e-mail them as required. However, even though I do also provide below quite detailed descriptions (as well as black-and-white prints) of these particular 'space images', it is by no means imperative that they be obtained: rather, one may substitute some other astronomical shots if desired – so long as they each possess *colours and forms* that are quite similar to the corresponding original pictures. The following Internet websites, recommended by Steve Clark as a first port-of-call, are both fertile sources for downloading apropos celestial images:

1. <http://www.eso.org/outreach/gallery/astro/>
2. <http://opposite.stsci.edu/pubinfo/pictures.html>

Although the original technology used for image-projection at **Arcturus Timespace**'s première (in 1987) comprised two powerful slide-projectors possessing 'dissolve' capabilities, I envisage that nowadays, some sort of computer projection-system would be employed instead. Whatever apparatus one eventually utilizes, it should be deployed a fair distance away from the performance zone itself, and must therefore possess sufficient candlepower to project every image effulgently.

In my score of **Arcturus Timespace**, large circled numbers depict the unalloyed manifestation of each heavenly image; these circled numbers have all been positioned therein quite specifically, so that image-projection should always be quite accurately synchronized with the electroacoustic 'tape' part.

The constituents of each of the sixteen colour slides which were projected during the première performance of **Arcturus Timespace** are as follows (in order):



- 1 An image of the Orion nebula, a gas-cloud in the constellation Orion: a dense pink-red cloud, below which is a brilliant white star surrounded by an eye-catching blue-purple corona; the background field contains quite a few stars. In summary, two contrasting shapes – blue versus red...



- 2 An image of the 'radio galaxy' Centaurus A, a giant yellow-brown elliptical galaxy crossed by a dark, complex lane of interstellar dust; the background field is dark-blue/purple and contains myriad stars.



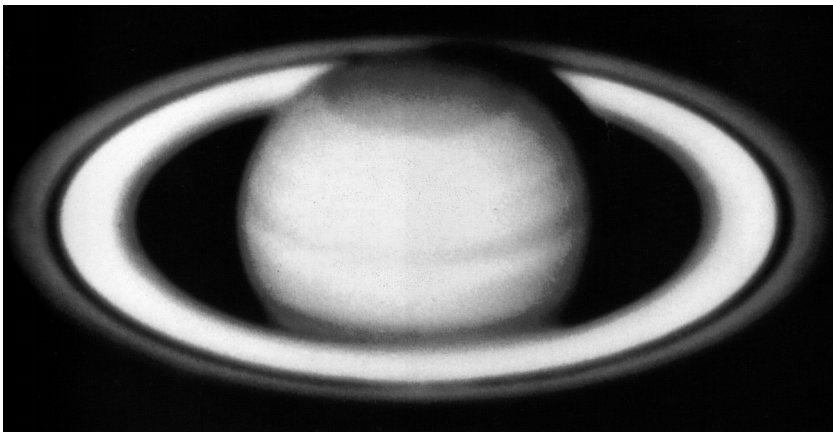
- 3 An image of the Veil nebula (the remnants of an old supernova): filigree red wisps of gently glowing gas loop across thousands of background stars from the Milky Way, in the constellation Cygnus.



- 4 An image of our Earth, photographed by Apollo astronauts between the Earth and Moon; the globe fills this shot. Outlines of Africa and Arabia are easily recognized, but cirrus clouds decrease the visibility of the Sahara region. Clouds rim many coastlines, while hurricanes rage in the southern oceans; the south polar-cap is also cloud-covered.



- 5 An image of the Lagoon nebula (also known as M8): a glowing red cloud of gas in the constellation Sagittarius, bisected by a dark lane of interstellar dust; the nebula itself possesses a brilliant white core, all against a blue-green field containing numerous stars.



- 6 An image of the planet Saturn and its rings, viewed at an angle of approximately 45° (and seemingly out-of-focus slightly): the rings are green, very dark blue, and white; the planet itself is primarily yellow.



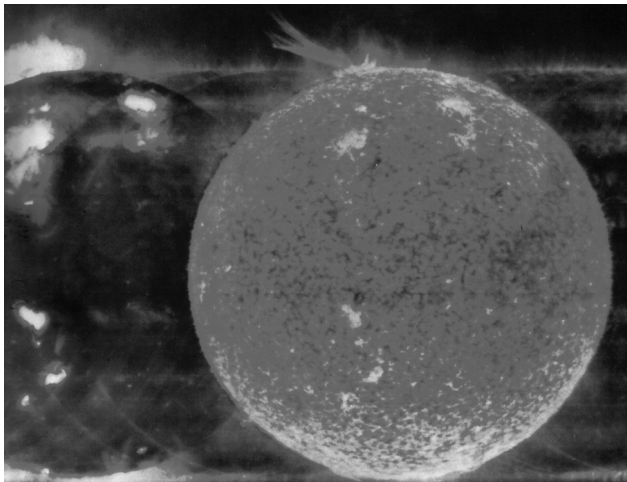
- 7 An image of the Eta Carinae nebula, a stunningly beautiful and complex cloud of luminous gas in the southern Milky Way: a large smoky-red region (with brilliant white and dark patches), shot through by myriad stars against a dark background.



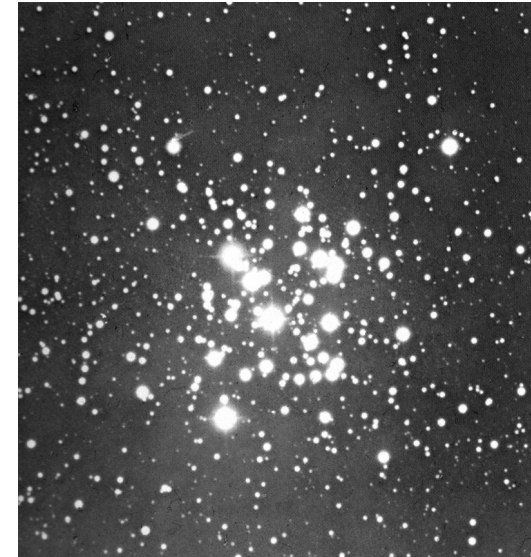
- 8 An image of the spiral galaxy Messier 83, in the constellation Hydra: it is yellow-brown, with multihued stars, set against a dark-green field containing relatively few bright objects.



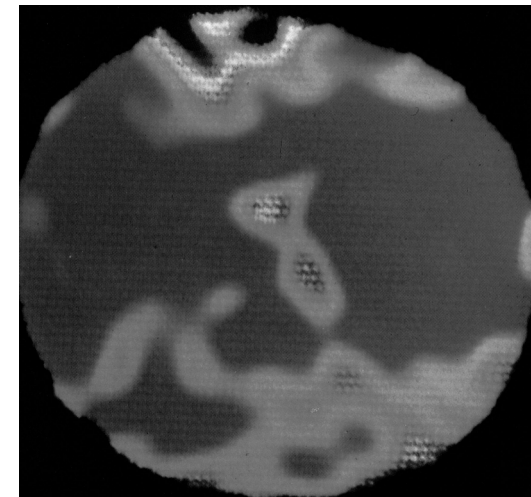
9 *An image of the Coalsack, a dark cloud of dust in the constellation Crux: it is a dark 'hole' in the middle of a dense field of stars within the Milky Way.*



10 *Several striking superimposed images – multiple exposures? – of the Sun: very fiery and powerful orbs ... reds, yellows and oranges, with some darker regions.*



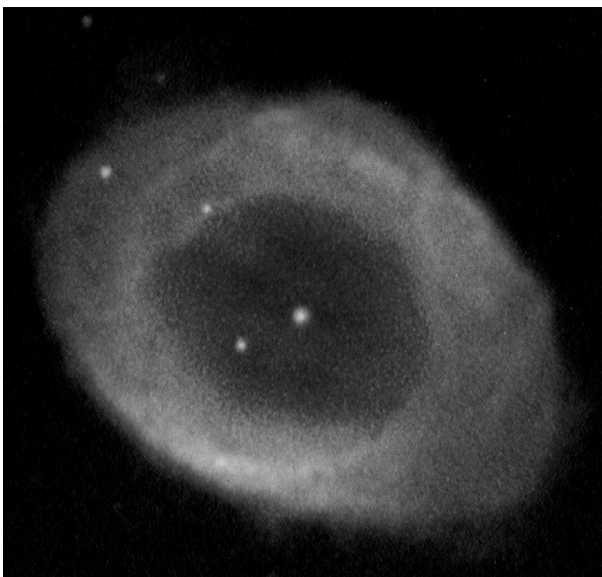
11 *An image of the open star-cluster NGC 3324, a dense agglomeration of stars: its biggest star is a red supergiant; the others are all blue-white orbs set against a darker blue-green background containing many stars.*



12 *An image of the red-giant star Betelgeuse (the brightest star in the constellation Orion), as resolved by the technique known as speckle interferometry: this is a computer-synthesized shot, consisting mainly of reds and oranges, with a few blue zones – representing cooler spots upon the star's surface.*



13 *An image of the Dumbbell nebula in the constellation Vulpecula: it is a blue, purple, and dark-red round, yet transparently luminous, gas-cloud set against a brilliant starry field.*



14 *An image of the Ring nebula in the constellation Lyra, at the centre of which is a white dwarf star: this nebula comprises a large red annulus-like ring (around a green central region), at the core of which is a small but visible blue-white star; the background is very dark.*



15 *A fantastic image of the Pleiades (also known as the Seven Sisters) in the constellation Taurus: this magnificent shot parades at least seven coruscative white stars, each surrounded by fuzzy bright-blue/purple wisps – all set against a dark, yet star-filled, background.*



16 = image 4 again.

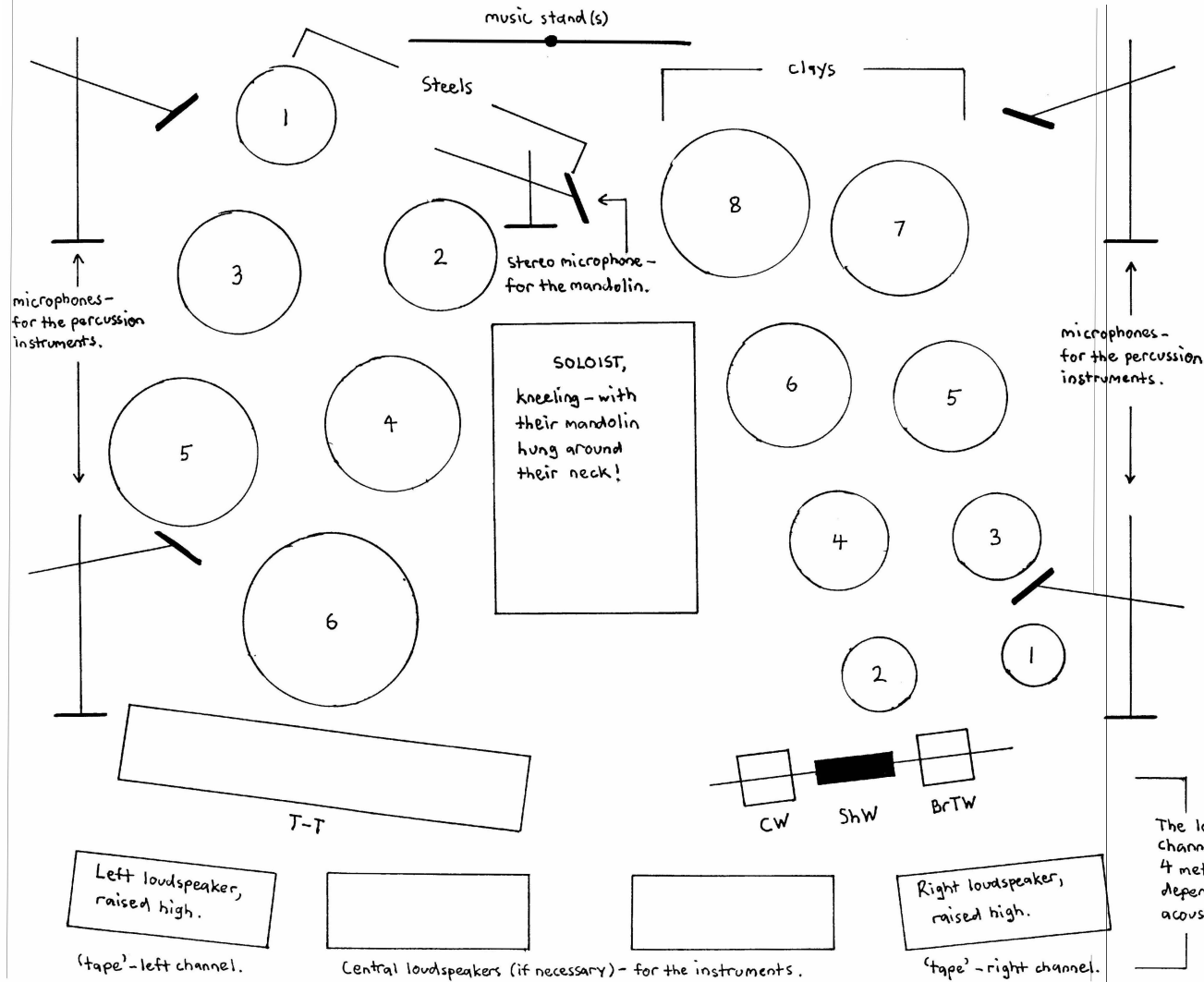
PHYSICAL LAYOUT OF THE INSTRUMENTS - NOT TO SCALE

AUDIENCE

Arcturus Timespace

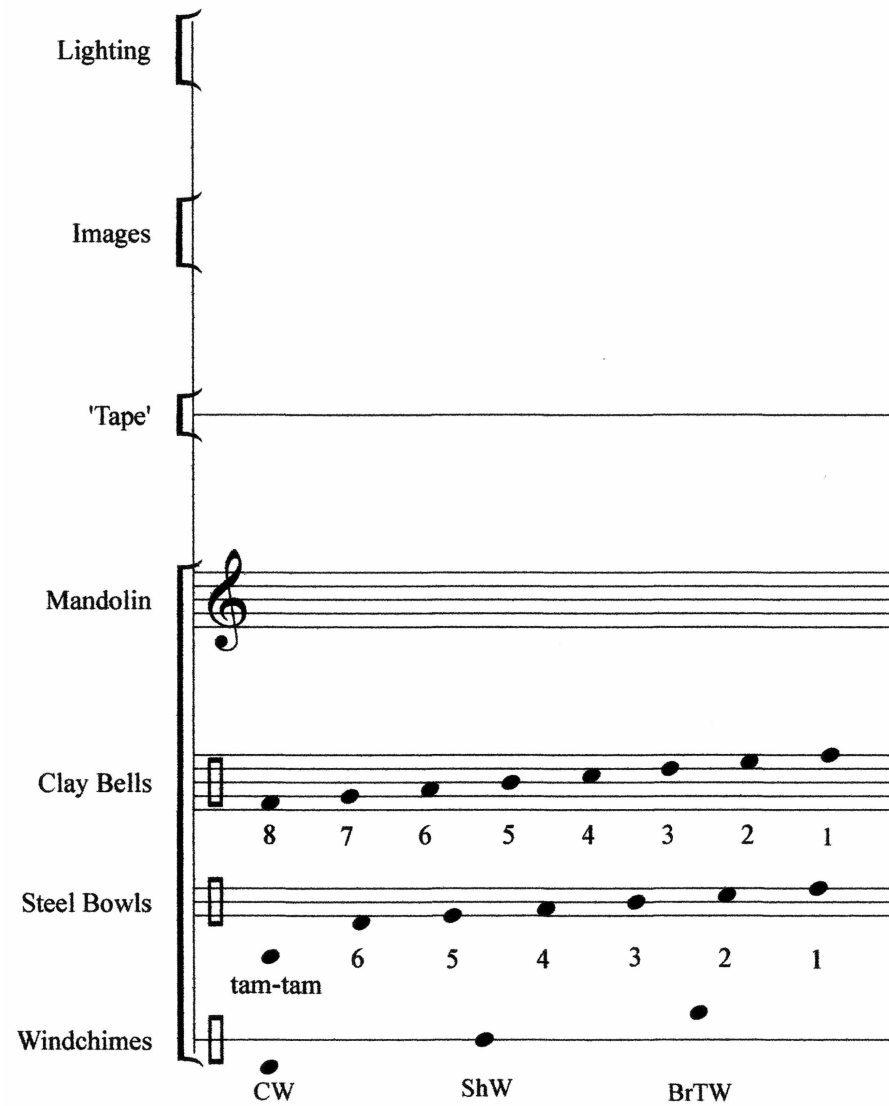
© Ian Shanahan,
Sydney, Australia, 1994

• To Ian Fredericks;
For Stephen Morey
to play...





Percussion Map



Arcturus Timespace

After the auditorium's house-lights have all been dimmed to complete darkness prior to the very beginning of **Arcturus Timespace**, the soloist moves quickly, silently, and furtively into playing position – their shoes having already been removed (as if one were entering some sacred space!).

Once the soloist is settled in place, remaining perfectly still, the deep blue background lighting and the first astral image are then slowly faded-in (approximately together).

A few seconds after the background lighting and initial projected image have achieved their full brightness, the soloist – as instructed by the score on p.1 – then picks up their mandolin and begins to play...

Arcturus Timespace

Ian Shanahan (1987/1994)

A

Lighting Fade from black to deep blue background lighting before the music begins.

Images 1 Projected before the music begins.

Extremely slow, infinitely calm and ritualistic, with a sense of suspended time - but rhythmically precise.

Quietly - but fairly quickly and fluidly - pick up the mallets with the right hand while the mandolin continues to sustain the E.

Mandolin M- finger A 5

In a ritualistic manner, slowly take up the mandolin and put it into playing position. *pp* *pochiss.* *p poss.* *p*

Clay Bells *mp* *p* *mf*

Steel Bowls *p* *mp* *p*

B

Images 10 Slow cross-fade to ... 2

'Tape' c.40.

Mand. M A plectrum Cue sound-projectionist

Clays *tr* *irregular attacks* *freely* *ppp* *mp* *p poss.* *mp* *pp* *mp* *p* *mp* *p* *pp*

Steels *p < mf mp* *mp* *mp* *mf* *pp*

C

Lighting [Commence a very slow change to red background lighting ...]

Images (4) Immediately begin a slow cross-fade to ...

Gradually increase the tempo to ♩ = c.80, as indicated - - - ♩ = c.42. - - - ♩ = c.43. - - - ♩ = c.44.

'Tape'

Mand.

Clays.

Steels

tr irregular attacks

Extend the duration, if desired

plectrum

mf

M

M very quickly

p

p

mf

p poss.

50

Images (5)

55

♩ = c.47. - - - ♩ = c.49. - - - ♩ = c.50. - - - ♩ = c.52.

'Tape'

Mand.

Clays.

Steels

pp

mf

p poss.

f

f poss.

clean, clear

gradually slow down the tremolo

non-trem.

M

A

M

A

mp

75

Images

Cross-fade to ...

80

'Tape'

Mand.

Clays.

Steels

mp *p* *f* *mf* *p*

mp *f* *p*

freely

mf

Extend the duration, if desired.

85

Images

Cross-fade to ...

9

Quickly cross-fade to ...

'Tape'

Mand.

Clays.

Steels

irregular attacks between the strings, gradually slowing down the tremolo

plectrum

ff *mp* *p poss.*

damp

precise

p *mf*

f poss.

fff

thumb + forefinger

finger

f poss.

soft

90

Lighting [Red background lighting; immediately commence a slow change back to deep blue background lighting ...]

Images (10) [Cross-fade to ...]

'Tape'

Mand. *fff* *fff* *p*

Clays.

Steels *f* *mf* *mf*

100 E 105

Images (11) [Cross-fade to ...] Gradually decrease the tempo to ♩ = c.40, as indicated. (12) [Immediately begin a slow cross-fade to ...]

'Tape'

Mand. *ff* *mp* *p poss.*

Clays.

Steels *p*

110

F

115

Lighting

Deep blue background lighting

Images

13

'Tape'

--- = c.62. 3 = c.58. = c.52. = c.48. = c.44. = c.40.

descending quartertones

final note of previous staggered chord, from which 'tape' textures arise. (The above graphic represents only the character and not the detail of the 'tape' sounds.)

recurring lower sound on 'tape'.

Mand.

3 A M 3

Slowly place the mandolin onto the floor in front of you, in a ritualistic manner.

Pick up the tuning forks and strike the strings hard behind the bridge of the mandolin with the tuning forks' tines, then quickly place their butts upon the bridge itself. *f poss.*

Clays.

Steels

15

Images

Begin a slow cross-fade to image 14 just after the start of the soloist's repeated phrase ...

after the SECOND time Begin a slow cross-fade to image 15 after the THIRD time ...

'tape' commences fade-out after the SECOND time...

'Tape'

Some temporal freedom is permissible from here onwards, but not so much as to lose the feeling of constancy: gently rocking.

etc ... finger (A)

Mand.

5 126 5

mp

Clays.

mf *p* *p* *mf* *p* *p* *mf* *p* *p* *mf* *p* *p*

Steels

p *p* *p* *p* *p* *p* *p* *p* *p* *p* *p* *p*

Wch

BrTW SbW CW

mp *p* *mf*

2.2 COSMOS (ONE NOTE)

2.2.1 INTRODUCTORY REMARKS

As can be gathered from a perusal of its Programme Annotation, **Cosmos (One Note)** draws upon a single Yamaha DX7 synthesizer ‘voice’ whose leisurely, subtle, and painstakingly constructed timbral evolution qualifies it – in the opinion of at least one expert-musician listener, Ian Fredericks – to be thought of as a ‘proper composition’, beyond a mere ‘sound’.¹ Anyway, this work came into being purely as an offshoot of my research into Frequency Modulation [FM] sound-synthesis carried out on a Yamaha DX7 synthesizer prior to composing **Arcturus Timespace**.

Although **A World of Becoming** is not the context to describe FM sound-synthesis or the architecture of the Yamaha DX7 synthesizer exhaustively,² some elucidation is, however, necessary – in order for me to be able to give a sketchy account of my compositional decision-making process in designing the above-mentioned Yamaha DX7 FM-synthesized ‘voice’.

The Yamaha DX7 synthesizer utilizes six “operators” (i.e. digital sine-wave oscillators, with envelope generators) that can be reconfigured into thirty-two patterns, or “algorithms”, of FM ‘carriers’ and ‘modulators’. **Cosmos (One Note)** calls for algorithm 13 – wherein operators 1 and 3 are independent carriers (here labelled c_1 and c_3), operator 2 modulates the frequency of c_1 , while operators 4, 5 and 6 autonomously modulate the frequency of c_3 (I designate these four modulators m_2 , m_4 , m_5 and m_6):

ALGORITHM 13				
	Block 1			Block 2
Modulators (m_4 , m_5 , m_6 , m_2)	4	5	6	2
Carriers (c_3 , c_1)		3		1
FM Sound Outputs		↓		↓

These two blocks of operators’ outputs are then mixed together inside the Yamaha DX7 to form the ‘voice’ *ShanEvol 1* that lies behind **Cosmos (One Note)**. Furthermore, operator 6 also ‘feeds back’ into itself: my feedback level of 3 therefore injects some additional noise-content into this voice’s timbral profile.

With FM synthesis, the essential determinants of timbre are:

1. The carrier-to-modulator frequency ratios (usually written as $c:m$), which fix within an FM sound-spectrum the set of available frequencies – namely, a carrier's frequency c Hz, and its symmetrical pairs of sidebands' frequencies $c \pm km$ Hz, where m Hz is the modulator's frequency and k is a whole number, $k \geq 1$; and
2. The 'modulation index' I , which dictates the amplitude of each sideband-pair $c \pm km$ Hz. Indeed, I is itself a function of a modulator's envelope, which varies over time, so that the resulting sound-spectrum is temporally dynamic and the FM timbre therefore behaves naturalistically.

The Yamaha DX7 algorithm behind **Cosmos (One Note)** blends four basic FM timbres that stem from the operator $c:m$ -pairs $c_1:m_2$, $c_3:m_4$, $c_3:m_5$ and $c_3:m_6$; all of their sound-spectra are *inharmonic* (e.g. the frequency ratio $m_2:c_1 \approx \sqrt{2}$). My 'orchestration' of these four FM timbres is controlled by the unusually low envelope-generator (EG) rates, which in turn regulate their modulation indices as well as the rate whereby each timbre fades in and out compared with the other timbres. To some extent, these timbres have also been 'decoupled' from one another through a diversification of the operators' six sets of EG rates. Moreover, the EG levels and operator output levels define the ceilings of each modulation index and thus the maximum spread of each spectral bandwidth.

In creating the Yamaha DX7 voice *ShanEvol 1*, one of my goals was to ensure that its slowly evolving timbral signature would be characterized by a 'natural inner liveliness'. Success in this area has been attained, I believe, by adopting three strategies:

1. A fastidious implementation of the Detune parameter for each operator: because operators 1 and 3 are carriers with exactly the same frequency setting but different amounts of detuning, *amplitude modulation* (in the guise of *beats*) is induced between them; detuning of modulators finely adjusts spectral frequencies, and can thereby cause similar beating and phasing effects.
2. Such periodic acoustical artefacts were then rendered more complex (and less obviously cyclical) by bringing to bear upon every operator the Yamaha DX7's Low Frequency Oscillator (LFO), whose unhurried rate of oscillation – which was deliberately chosen to be incommensurable to any beat-frequencies within this voice's sound – modulates sinusoidally each operator's pitch to a small degree. The LFO also oscillates somewhat the amplitudes of operators 5 and 6 (only), so that – being modulators within algorithm 13 – 'timbral vibrati' are engendered as their modulation indices fluctuate.
3. A maximum LFO delay setting of 99 postpones the LFO's operation to some extent – so

as to prolong the aural illusion of non-periodic vibrato as long as possible before one discerns any conspicuous regularity having entrenched itself.

During live performances of **Cosmos (One Note)**, whenever the Yamaha DX7 synthesizer's output has been boosted at the mixing desk to quite a high level, the unremitting loudness of this piece's continuous 'wall of sound' renders it almost physical: in effect, it becomes an overpowering 'aural sculpture' – rather reminiscent of the sonic landscapes created by the New-York-based minimalist composer Phil Niblock.³

A final point: although my Performance Instructions to **Cosmos (One Note)** require the synthesizer player to “depress the “Middle C” (C3) key – only – with the *strongest possible attack!*”, this performative action is, I have to say, entirely theatrical – given that within *ShanEvol 1* all operators' key-velocity sensitivities have been set to 0. So however quickly or forcefully its C3 key is depressed, an identical sound will always ensue from the Yamaha DX7 synthesizer.

ENDNOTES

1. Moreover, one could advance the argument that, as a 'proper composition', **Cosmos (One Note)** is auto-analytical – in that my Yamaha DX7 voice-parameters 'analyse' this sound.
2. For a comprehensive study of FM sound-synthesis techniques and the Yamaha DX7 keyboard synthesizer, consult Bristow (n.d.), Chowning (1973), Fukuda (1985), LeBrun (1977), Morrill (1977), ed. Roads & Strawn (1985), Saunders (1977), Schottstaedt (1977), ed. Strawn (1985), Truax (1977), and Truax (1981).
3. caleb k (2000), p.37 reviews a recent presentation in Sydney of some of Niblock's works.

Ian Shanahan (1987 / 1997)

– *To Ο Παναγιος*

For anybody to play:

~~~~~

# *Cosmos (One Note)*

for

solo Yamaha DX7 keyboard synthesizer

~~~~~

Cosmos (One Note) was premièred by Ian Shanahan (Yamaha DX7 keyboard synthesizer) during a “Sound Kitchen” concert held at The Performance Space, in the Department of Music, School of Contemporary Arts, the University of Western Sydney (Nepean), Kingswood, Sydney, on 13 November 1997.

PROGRAMME ANNOTATION and PERFORMANCE NOTES

Cosmos (One Note) for solo Yamaha DX7 keyboard synthesizer

Ian Shanahan (1987/1997)

Music is the embodiment of the intelligence that exists in sound.

– Hoëné Wronski (1776–1853).

*To see a World in a Grain of Sand
And a Heaven in a Wild Flower,
Hold Infinity in the palm of your hand
and Eternity in an hour*

– William Blake: from **Auguries of Innocence** (from the Pickering MS).

While attempting to penetrate the mysteries of Frequency Modulation sound synthesis on a Yamaha DX7 synthesizer – preparatory to composing the tape part of my multimedia piece **Arcturus Timespace** (1987) – I was distracted by the potentialities of synthesizing DX7 sounds that evolve meaningfully over unusually long periods: spanning minutes instead of seconds! (For the benefit of the technically inquisitive, such slow timbral germination required painstaking adjustments of, and infinitesimal disparities between, [low] envelope-generator rates, the operator output levels and their detunings, and very careful specification of Low Frequency Oscillator settings that act upon both pitch- and amplitude-modulation parameters.) Anyway, Ian Fredericks, then Director of the Sydney University Experimental Sound Studio [SUESS] where I was carrying out this research, remarked positively upon one of these DX7 voices, to the effect that: “this isn’t just a Yamaha DX7 sound, it’s a whole god-damned piece!”. At the time, in 1986, I stupidly thought nothing of Ian’s perspicacious observation – until a decade or so later, when I stumbled upon this work once again. Of course, he’s right! So, now fully appreciating Mr Fredericks’ insightfulness, I tweaked a couple of parameters and named the thing **Cosmos (One Note)** ... because that’s exactly what it is.

Closer to the time of its première, I mischievously savoured the likelihood that **Cosmos (One Note)** may just ‘put a cat amongst the pigeons’: given many commentator-pundits’ current fetish for constructing often chimeric musical taxonomies, I relished the difficulty they might have in ‘pigeon-holing’ this piece (“*minimalist* in its performative action, but *maximalist* in its acoustical inner life – so just what *do* we label it?”); moreover – to invoke the ungainly jargon of musicological new-speak – because of the Yamaha DX7 keyboardist’s almost complete physical immobility, **Cosmos (One Note)** ‘problematizes’ the *spectacle* of live performance. But such academicism does not really concern me here. I merely invite you to explore the sonic universe of this “whole god-damned piece”, moment-by-moment, with your minds and ears rather than your eyes...

PROGRAMMING THE YAMAHA DX7 KEYBOARD SYNTHESIZER

Cosmos (One Note) embraces only one Yamaha DX7 ‘voice’, *ShanEvol 1* (created by the composer)! All of its parametric data is provided below. Therefore, having initialized one of the 32 voices somewhere on this synthesizer, program these settings, precisely, into the machine.

PERFORMANCE INSTRUCTIONS

Having preselected the DX7 voice *ShanEvol 1*, depress the “Middle C” (C3)* key – only – with the *strongest possible attack*! Now stay perfectly still, statue-like, holding this key down until the sound definitely ceases to evolve – after approximately four minutes. Wait a few moments longer, then *furtively* release this key, remaining as quiescent as possible until several seconds have elapsed *after the sound has finally faded into total inaudibility*. (The piece is over when you relax, at last.)

VOICE NAME: *ShanEvol 1*

Created by: Ian Shanahan

Algorithm: 13

Feedback: 3

Key Transpose: C3

Pitch Modulation Sensitivity: 1

Oscillator Synchronization: On

LFO:	Wave	Speed	Delay	PMD	AMD	Sync
	Sine	02	99	05	16	On

	Op.1	Op.2	Op.3	Op.4	Op.5	Op.6
Ampl. Mod. Sens.:	0	0	0	0	1	2
Mode:	Ratio	Ratio	Ratio	Ratio	Ratio	Ratio
Frequency:	00.50	00.70	00.50	01.41	03.22	00.60
Detune:	-1	-7	+0	-7	-6	+2
EG Rate 1:	08	02	08	03	99	00
EG Rate 2:	00	03	00	04	11	04
EG Rate 3:	00	00	00	00	00	00
EG Rate 4:	05	17	03	10	00	15
EG Level 1:	99	91	99	79	51	99
EG Level 2:	91	74	92	99	61	71
EG Level 3:	99	99	99	82	78	99
EG Level 4:	00	00	00	00	00	00
Keyboard Level Scaling						
Break Pt.:	A-1	A-1	A-1	A-1	A-1	A-1
Curve L:	-LIN	-LIN	-LIN	-LIN	-LIN	-LIN
Curve R:	-LIN	-LIN	-LIN	-LIN	-LIN	-LIN
Depth L:	00	00	00	00	00	00
Depth R:	00	00	00	00	00	00
Kbd. Rate Scaling:	0	0	0	0	0	0
Op. Outpt. Level:	99	90	99	93	99	99
K. Velocity Sens.:	0	0	0	0	0	0

Pitch EG

Rate 1: 99	Rate 2: 99	Rate 3: 99	Rate 4: 99
Level 1: 50	Level 2: 50	Level 3: 50	Level 4: 50

Poly/Mono: Poly

Pitch Bend:	Range	Step
	00	00

Portamento:	Mode	Glissando	Time
	Sus-Key P Retain	Off	00

	Range	Pitch	Amplitude	EG Bias
Modulation Wheel:	00	Off	Off	Off
Foot Control:	00	Off	Off	Off
Breath Control:	00	Off	Off	Off
Aftertouch:	00	Off	Off	Off

* NB: Assuming that A3 = 440 Hz, then C3 [MIDI note number 60] \approx 261.6255653 Hz.

2.3 SOLAR DUST: ORBITS AND SPIRALS

2.3.1 BRIEF ANALYTICAL NOTES

As my Programme Annotation to **Solar Dust: Orbits and Spirals** reveals,

The title of this work “Solar Dust” is derived from some poetry I wrote in 1986 [the poem in question has been reprinted within the score], though the sound-world of the piece is intended to evoke the image of a particular ‘spacescape’ painting – I do not recall the artist – in which one observes the planet Saturn through the myriad of ice crystals and other nebulous matter which comprise its rings. Therefore, much of **Solar Dust** consists of filigree sound-atoms: delicate, subtle, and detailed sonic events that warrant careful and refined listening, but which also outline a larger macrostructure.¹

This “larger macrostructure” is fleshed out, in detail, by the following form-plan for **Solar Dust: Orbits and Spirals**:

- Section A: A_0 (p.1, opening event: a single $B_{\frac{1}{2}}$);
 A_1 (p.1, $\text{♩} = ca.53$: a developed quotation from **Arcturus Timespace**); †
 A_2 (p.1, $\text{♩} = ca.98$: {declamatory antecedent – x} and $B_{\frac{1}{2}}$ harmonics etc. {consequent – y});
 A_3 (p.1, systems 2–3: a 27-note *isomelos*, in harmonics); ‡
 A_3^* (p.1, systems 3–4: the 27-note *isomelos* again, but ‘string-drummed’ over $B_{\frac{1}{2}}$ drones, and embedded amongst other ‘string-drummed’ tones of indeterminate pitch); ‡
 A_1^* (p.1, system 4, to p.2, system 1, $\text{♩} = ca.70$); A_0^* ;
 A_2^* (p.2, $\text{♩} = ca.98$: {declamatory counterpart to x – x*});
 $A_3 \cup A_3^*$ (p.2, systems 2–3: a truncated intermingling of *isomeloi*); ‡
 A_3^{**} (p.2, system 3: a 20-note pitch-sequence, in harmonics – a truncated retrograde of A_3 , including a free re-ordering of certain elements from A_3); ‡
 A_1^{**} (p.2, system 4, $\text{♩} = ca.98$);
 $A_2 \cup A_2^*$ (p.2, system 4: an intermingling of pitches – i.e. $x \cup x^*$);
 A_0^{**} (p.2, system 4, to p.3, system 1: a multiple $B_{\frac{1}{2}}$ glissando, and then a ca.7" stasis);
- Section B: B_1 (p.3, systems 1–2: a complex phrase of [mainly] $B_{\frac{1}{2}}$ s, reiterated over and over again, being a considerable evolution of A_1);
textual instructions, transforming B_1 ;
 B_1^* (p.3, system 3, to p.4, system 2: two successive ‘disintegrations’ of B_1 , achieved by omitting ever more of its sonorities); A_2^{**} (p.4, system 2: a permutation of x which momentarily interrupts the second ‘disintegration’ of B_1 within B_1^*);
 A_0^{***} (p.4, system 3: merely a slight variant [in vibrato-type] of A_0^*);
 A_1^{***} (p.4, systems 3–4, $\text{♩} = ca.53$: a ‘harmonization’ of the first three tones from A_1);
‘codetta’ (p.4, system 4: silence and stasis).

† The source for this quoted material is located in **Arcturus Timespace** (1987/1994) within section B – i.e. those three $B_{\frac{1}{2}}$ s, plucked *molto sul ponticello* to *molto sul tasto* – and within section A (just before the tam-tam stroke) – i.e. the accelerating grace-note group (transposed herein).

‡ These *isomeloi* shall be tabulated below. NB: the penultimate paragraph of my Programme Annotation² serves to encapsulate the global morphology of **Solar Dust: Orbits and Spirals**:

“Much of the pitch-material of **Solar Dust** – which falls into two main sections – grows out of a brief quotation, a germinal fragment from an earlier work of mine that also utilizes the mandolin: **Arcturus Timespace** (1987/1994). This minuscule passage [subsection A₁], consisting of just the same pitch reiterated three times (but with diverse plucking-positions and colours), is declared near the beginning of **Solar Dust** and forms an anchor-point for the variegated material of the first section [viz. subsection A₁ returns as A₁*, and then afterwards as A₁**]. Consequently, the composition as a whole revolves around this pitch (B-natural, with microtonal deviations)! And yet **Solar Dust: Orbits and Spirals** is definitely *not* ‘tonal’! The second section of **Solar Dust** juxtaposes detailed and precise musical instructions with considerable degrees of freedom for the mandolinist – in order to heighten the performative attributes of virtuosity and intensity. Here, an extended ‘theme’ [subsection B₁] – composed primarily of the abovementioned ‘B-naturals’ – undergoes a process of gradual metamorphosis while being repeated incessantly... Notions of tension and release are then imposed upon the work as a whole, to forge climactic points and places of repose”.

A₃ isomelos (in harmonics)

pitches:	G ₄	F ₄ #	B ₄ ♭	B ₄ ♯	D ₄ ♯	G ₄ #	A ₄ ♯	E ₄ ♯	G ₄ ♯
ordinal numbers:	1	2	3	4	5	6	7	8	9
pitches:	D ₄ ♯	B ₄ ♭	F ₄ #	A ₄ ♯	B ₄ ♯	D ₄ ♯	G ₄ #	G ₄ ♯	A ₄ ♯
ordinal numbers:	10	11	12	13	14	15	16	17	18
pitches:	D ₄ #	E ₄ ♯	F ₄ #	B ₄ ♭	C ₄ #	D ₄ ♯	A ₄ ♯	E ₄ ♯ ...	G ₄ ♯
ordinal numbers:	19	20	21	22	23	24	25	26	27

A₃* isomelos (‘string-drummed’)

pitches:	... G ₄ ♯	F₄ #	A ₄ #	B ₄ ♯	D ₄ ♯	G ₄ #	A ₄ ♯	E₄ ♯	G₄ ♯
ordinal numbers:	1	2	3	4	5	6	7	8	9
pitches:	D ₄ ♯	A₄ #	F₄ #	A ₄ ♯ ...	B ₄ ♯	D ₄ ♯	G₄ #	G₄ ♯	A ₄ ♯
ordinal numbers:	10	11	12	13	14	15	16	17	18
pitches:	D ₄ # ...	E ₄ ♯	F ₄ #	B ₄ ♭	C₄ #	D ₄ ♯	A ₄ ♯	E ₄ ♯ ...	G ₄ ♯...
ordinal numbers:	19	20	21	22	23	24	25	26	27

NB: pitches herein whose octaves have been displaced relative to those of subsection A₃’s *isomelos* are set in **bold-face** type.

A₃ ∪ A₃*

A ₃ ordinals:											25		27			
A ₃ * ordinals:	...	10	11	12	4	5	6	8	9		11	12	13		...	15 16
A ₃ ordinals:		24			26											
A ₃ * ordinals:	17		18	19		...	20	21	22	23	24	25	26	...		

A₃ 20-note pitch-sequence (in harmonics)**

pitches:	C ₄ #	F ₄ #	E ₄ ♯	A ₄ ♯	G ₄ ♯	G ₄ #	D ₄ ♯	B ₄ ♯	A ₄ ♯	F ₄ #
A ₃ ordinals:	23	21	20	18	17	16	15	14	13	12
pitches:	E ₄ ♯	G ₄ ♯	E ₄ ♯	D ₄ ♯	D ₄ ♯	B ₄ ♯	D ₄ ♯	G ₄ ♯	B₄ ♯	A₄ #
A ₃ ordinals:	8	27	26	10	24	4	5	1	4?	3?

NB: pitches herein whose octaves have been displaced relative to those of subsection A₃’s *isomelos* are set in **bold-face** type.

Why is **Solar Dust: Orbits and Spirals** ‘gravitational pitch-class’, around which all of its other sonic materials revolve, specifically a B₄? Now beyond the fact that B₄ happens to be the predominating pitch-class of subsection A₁ – that “germinal fragment” from my **Arcturus Timespace**, out of which **Solar Dust** grows – I soon discovered (while preparing my technical charts) that B₄ offers, statistically, the most diversified timbral potentialities – if one also necessarily considers the mandolin’s (natural) harmonics *and* its bitones, the latter of which encompass several microtonal variants of B₄. Indeed, *timbre* does play a truly pivotal rôle in the weaving together of this composition’s sound-fabric:

At a technical level, my conceptual approach to the mandolin was rather unorthodox. **Solar Dust** treats this instrument purely as a sound-generator devoid of any specific cultural resonances, an ‘acoustical tool’ that embraces four distinct (but interrelated) elements: {1} the string-length between the bridge and the tailpiece; {2} the string-length between a stopping finger (if any) and the bridge; {3} the string-length between a stopping finger and the nut (the so-called ‘bitone’ register, prized for its controllable microtonal resources); and {4}, the string-length behind the nut. These elements are all interwoven into a complex tapestry of timbral counterpoint. At times, the mandolinist’s exertions in creating this amalgam bestow an additional theatrical or gestural dimension that is intended to enhance the music in live performance.³

Moreover, one can easily observe a direct correlation between the mandolin’s timbres – as determined by plucking position – and the player’s physical actions: throughout the composing of **Solar Dust: Orbits and Spirals**, plucking positions were thoughtfully chosen to ensure that the mandolinist’s right-arm motions would be ‘sensibly directional’ (and not seemingly random) – to secure some degree of kinetic fluidity, rather than inertial jerkiness; such smooth, deft, yet celeritous right-hand activity is of paramount significance for the spectacular, wild gesturality that erupts within section B.

What of **Solar Dust**’s subtitle, “Orbits and Spirals”?⁴ It “clearly imports further astronomical evocations, but also relates to a structural schema wherein musical material recurs unchanged (i.e. orbits) or is transformed (i.e. spirals). This basic idea is applied at various architectonic levels, from whole phrases and statements down to successive pitches (i.e. unison ≈ ‘orbit’; different octave ≈ ‘spiral’).⁵ The young Australian virtuoso-mandolinist Michael Hooper, who recently performed and re-recorded **Solar Dust: Orbits and Spirals**, sagely opines that

Orbits and spirals can be useful to a composer in several ways. An orbit may be considered synonymous with the unchanging aspects of a piece because, over time, the object in orbit will return to the original starting position. A spiral is an orbit which involves dilation in addition to rotation, and therefore can be described as an ‘automorphic transformation’, which is, in other words, a [metamorphosis] that causes *some* aspect of the transformed object to remain invariant. An object following a helical path will never return to its original position. However, at various points throughout [its] path, the object will return to an analogous position. This is useful to the composer, for it allows a conceptual unification of the two processes. For

example, when viewed from a position perpendicular to the plane in which the object is rotated, an orbit and a spiral may appear congruent. Yet when viewed [in] parallel to [this] plane, the orbit and the spiral will appear quite different. The path of the orbit will appear as a straight line, [while] the path of the spiral will appear as a sine wave. Thus, combining [these] two paths in a composition allows for periodicity in multiple directions.⁶

Solar Dust: Orbits and Spirals is dedicated to one of Michael's uncles, the superb mandolinist Paul Hooper (who delivered **Solar Dust**'s world-première performance during September 1988), and also to Michael's father, Adrian Hooper (who commissioned it in the first place).

ENDNOTES

1. **Solar Dust: Orbits and Spirals**, Programme Annotation.
2. *ibid.*
3. *ibid.*
4. The symbolism of the spiral form has already been surveyed within section 1.2.9.
5. **Solar Dust: Orbits and Spirals**, Programme Annotation.
6. Ian Shanahan: **Solar Dust: Orbits and Spirals**, Programme Annotation by Michael Hooper; quoted from the Concert Programme for a Senior Examination Recital held at the Great Hall, the University of Sydney, on 13 September 2000.

Ian Shanahan (1988 / 1999)

– *To Adrian and Paul Hooper*

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*Solar Dust*  
*Orbits and Spirals*

for  
solo mandolin

~~~~~

PROGRAMME ANNOTATION

Solar Dust: Orbits and Spirals

for solo mandolin

Ian Shanahan (1988/1999)

Solar Dust: Orbits and Spirals was commissioned by Adrian Hooper and The Sydney Mandolins, for performance by Adrian's brother Paul – a mandolinist of considerable virtuosity. My intention was to create a work which exploited (and even extended) Paul's technical capabilities. The composition was completed in March 1988, receiving its first performance in September of that year. It has since been played, broadcast, and recorded by Paul Hooper (and his students) on numerous occasions – and also most notably by the Melbourne-based mandolinist Stephen Morey. **Solar Dust** was chosen by the Australian Branch of the International Society for Contemporary Music [ISCM] as part of our National Entry to the 1990 ISCM World Music Days, to be held in Oslo, Norway.

The title of this work "Solar Dust" is derived from some poetry I wrote in 1986, though the sound-world of the piece is intended to evoke the image of a particular 'spacescape' painting – I do not recall the artist – in which one observes the planet Saturn through the myriad of ice crystals and other nebulous matter which comprise its rings. Therefore, much of **Solar Dust** consists of filigree sound-atoms: delicate, subtle, and detailed sonic events that warrant careful and refined listening, but which also outline a larger macrostructure. (In order for such sounds to be perceived intimately, the mandolin must often be subtly amplified in performance.)

The subtitle "Orbits and Spirals" clearly imports further astronomical evocations, but also relates to a structural schema wherein musical material recurs unchanged (i.e. orbits) or is transformed (i.e. spirals). This basic idea is applied at various architectonic levels, from whole phrases and statements down to successive pitches (i.e. unison \approx 'orbit'; different octave \approx 'spiral').

At a technical level, my conceptual approach to the mandolin was rather unorthodox. **Solar Dust** treats this instrument purely as a sound-generator devoid of any specific cultural resonances, an 'acoustical tool' that embraces four distinct (but interrelated) elements: {1} the string-length between the bridge and the tailpiece; {2} the string-length between a stopping finger (if any) and the bridge; {3} the string-length between a stopping finger and the nut (the so-called 'bitone' register, prized for its controllable microtonal resources); and {4}, the string-length behind the nut. These elements are all interwoven into a complex tapestry of timbral counterpoint. At times, the mandolinist's exertions in creating this amalgam bestow an additional theatrical or gestural dimension that is intended to enhance the music in live performance.

Much of the pitch-material of **Solar Dust** – which falls into two main sections – grows out of a brief quotation, a germinal fragment from an earlier work of mine that also utilizes the mandolin: **Arcturus Timespace** (1987/1994). This minuscule passage, consisting of just the same pitch reiterated three times (but with diverse plucking-positions and colours), is declared near the beginning of **Solar Dust** and forms an anchor-point for the variegated material of the first section. Consequently, the composition as a whole revolves around this pitch (B-natural, with microtonal deviations)! And yet **Solar Dust: Orbits and Spirals** is definitely *not* 'tonal'! The second section of **Solar Dust** juxtaposes detailed and precise musical instructions with considerable degrees of freedom for the mandolinist – in order to

heighten the performative attributes of virtuosity and intensity. Here, an extended 'theme' – composed primarily of the abovementioned 'B-naturals' – undergoes a process of gradual metamorphosis while being repeated incessantly... Notions of tension and release are then imposed upon the work as a whole, to forge climactic points and places of repose.

Solar Dust: Orbits and Spirals is dedicated to Paul and Adrian Hooper.

© Ian Shanahan, Sydney, Australia; 17 September 1989.

Solar Dust: Orbits and Spirals was premièred by Paul Hooper during a Sydney Mandolins concert held at The Netherlands Uniting Church, Quarry Street, Ultimo, Sydney, on 9 September 1988.

Two recordings of **Solar Dust: Orbits and Spirals**, played by Paul Hooper and by Michael Hooper, are now commercially available on the Compact Discs "Solar Dust" and "American Dream" (Broad Music Records Jade JAD CD 1080 and JAD CD 1090, respectively).

CELESTIAL CONJUNCT

(In celebration of an Artistic Alliance.)

Sun's Solar Flares
lick at the Dust, but barely
penetrate your shadows;

Moon's Scimitar
cuts the Cosmos, yet cannot
sever your icy shapes;

You, of The Grand Cross,
who knots together our Brainflowers:
Cold Neptune!

I. L. Shanahan, 13.3.1986.
– To Donald Stallybrass.

PERFORMANCE NOTES

CHARACTERISTICS OF THE MANDOLIN, AND STAGE SET-UP

Solar Dust: Orbits and Spirals assumes a normal mandolin – Flat-back or Neapolitan – possessing at least 19 frets. For maximum visual impact in performance, the mandolinist's music stand(s) should be set *as low as possible*.

AMPLIFICATION OF THE MANDOLIN

Although the mandolin should not need to be amplified in an intimate chamber music context, if **Solar Dust: Orbits and Spirals** is to be performed in larger auditoria (where considerable sound-projection is required), some sound-reinforcement of the instrument will prove necessary in order to achieve adequate acoustical projection. Amplification with a high-quality cardioid or omnidirectional condenser microphone is suggested. Optimally, the loudspeaker(s) for the mandolin should be positioned near the mandolinist, so as to create the impression of a single sound-source for the instrument. In any event, the level of amplification ought to be kept to a minimum, so that the mandolin's natural timbre will be heard as clearly as possible: discreetly implement sound-reinforcement *only when necessary*.

TUNING OF THE OPEN STRINGS

One string on each course of the mandolin is to be very slightly lowered in pitch, thereby producing a richer basic timbre: a 'chorus effect'. The resultant beat-frequencies should be no greater than 4 – 5 Hz (beats-per-second) on the open strings, with different beat-frequencies being generated upon each (open) course; precise details are left to the discretion of the mandolinist.

SPECIFICATION OF COURSES

The course to be played upon at any given moment is indicated in the usual manner: G, D, A, E (each letter being ringed within the score). When such a symbol is omitted, either the musical context renders the choice of course obvious, or a whole sequence of notes is to be played upon the same course as specified at the beginning of the sequence.

ACCIDENTALS

The use of accidentals is kept to a minimum in **Solar Dust: Orbits and Spirals** – though some precautionary natural (♮) signs are utilized. Essentially, any accidental applies only to the note which it precedes.

DYNAMIC INDICATIONS


Apart from the usual dynamic indications (*ppp*, *pp*, *p*, *mp*, *mf*, *f*, *ff*, *fff*), the following symbols are employed in **Solar Dust: Orbits and Spirals**:


p poss. and *f poss.* are abbreviations for 'as soft as possible (but still audible)' and 'as loud as possible', respectively;

○ represents the final vanishing into *inaudibility*: allow the sound to resonate to *silence*.

Dynamic indications apply until they are modified by the next dynamic instruction.

PAUSES


 – The approximate duration of the pause is indicated in seconds above the *squared fermata*.

 – Pause as indicated. (Precise durations are left to the discretion of the mandolinist.)

The durations of other pauses are determined by instrumental characteristics or other acoustical properties: "Pause until the sound is lost in the distance"; "Pause until the dynamic level falls to '*mp*'"; etc. A squared fermata (⌋) is given in conjunction with such verbal instruction.



GRACE-NOTE GROUPS



Grace-note groups all lie 'outside time' – locally independent of any other durational schemata. In general, they should be played quite rapidly or even 'as fast as possible' (i.e. as [very] short indeterminate durations, left to the discretion of the player) – although tenuto markings and various pauses may be used to suggest a more leisurely or irregular approach. Indeed, nuances in horizontal spacing amongst grace-notes propound a correspondingly sophisticated rhythmic interpretation that is, notwithstanding, left to the mandolinist to some extent. Furthermore, despite their autonomous unfurling, grace-notes ought not to be thought of as mere 'ornaments', of secondary architectonic status, to the 'main notes': *all* sonorities in **Solar Dust: Orbits and Spirals** are equally important!


 – an *accelerando* within the grace-note grouping.


ARTICULATION AND RESONANCE


All strings must be allowed to ring on *as much as possible*. Noteheads marked with a small tie 'to nothing' (i.e. a '*lasciare vibrare*') are to be sustained, or left to resonate, beyond their given duration. (To a large extent, this directive, together with course specifications, determines the texture and hence the required fingerings.) The following symbology applies especially to articulation:

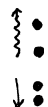
  – *up-* and *down-stroke*, respectively.

  – *tenuto* (hold the note for the full duration as given, or even a little longer) and *staccatissimo* (very short, *molto staccato*), respectively. These symbols do *not* imply the application of any additional accent or stress, unless otherwise indicated.

 – pluck only the first note and *hammer* or *pull-off* the subsequent notes with the left-hand fingers, according to the melodic contour.

 – *legato*: pluck only the first note, but for the subsequent notes, merely *place* or *lift* left-hand fingers on or off the fingerboard, according to the melodic contour.

 – pluck only *one string within the course*. (This directive applies to single notes only.) Unless this symbol is given, the number of strings per course that are to be plucked is left to the discretion of the mandolinist.



– *arpeggiate* the notes in a somewhat leisurely manner.



– *strum* (i.e. *rapidly arpeggiate*) the notes of the chord.

For both forms of *arpeggiation*, their speed of execution is left to the interpretation of the player. *Arrowheads* upon the above symbols indicate the *direction* of the arpeggio's action: ↑ = play the *lowest-pitched* course first; ↓ = play the *highest-pitched* course first.

PLUCKING MATERIAL



– pluck the string(s) with a *plectrum*. The point or the side (i.e. rounded edge) of the plectrum may be used at the discretion of the mandolinist.



– pluck the string(s) with the *right-hand index finger* (or *thumb*). The *pad* or the *tip* of the finger may be used at the discretion of the mandolinist.

Note: The specified plucking material is employed until the other is called for.

The mandolinist should seriously consider the possibility of holding the plectrum, *for the entire duration of the piece*, between the thumb and the *middle finger* of the right hand, since the right-hand *index finger* is used consistently as a sound-generator or -modifier in its own right.

TREMOLO



– a *tremolo* (successive up- and down-strokes) is to be executed very quickly or as quickly as possible (tastefully, according to the musical context).



– *tremolo for only part of the given duration*, allowing the string(s) to ring on for the remainder of the note. (The precise duration of the tremolo action is left to the interpretation of the mandolinist.)

When playing *tremoli* with a *plectrum*, the *side* (i.e. rounded edge) of the plectrum may be used in soft dynamic levels to impart a more gentle, slightly fuzzier quality than is usually obtained by using the plectrum's point.

Furthermore, in tremolo, a *diminuendo to very low dynamic levels* may be achieved by gradually rotating the flat face of the plectrum through 90° relative to the length of the string. (This tremolo technique was apparently developed by the Hoopers.)

When playing *soft tremoli* with the *finger*, the *fingertip* may be utilized instead of the pad in order to achieve a different subdued quality.

All of these techniques may be used at the discretion of the mandolinist.

PLUCKING POSITION

The following symbols are mostly affixed to the relevant note's *stem* – except in the case of plucking-position *transitions* in tremolo, when they are drawn *beyond the notehead*:



– *molto sul ponticello*: pluck the string(s) *very close* to the bridge indeed.



– *sul ponticello*: pluck the string(s) *close* to the bridge.



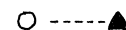
– the normal plucking position (abbreviation: *pos. ord.*) is notated in the usual fashion.



– *sul tasto*: pluck the string(s) 'up the neck' somewhat (on or towards the fingerboard), nearer to the middle of the vibrating string-length than usual.

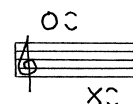


– *molto sul tasto*: pluck *precisely* at the middle of the vibrating length of the string(s) – directly above the twelfth fret for the open string(s), or directly above the fret which is twelve frets higher than that fret where the finger stops the string: this plucking position may actually be beyond the end of the fingerboard. Plucking the string(s) *molto sul tasto* will yield a timbre that is very mellow, rich in odd-numbered harmonics.



– *in tremolo only*, a smooth transition of plucking position (as indicated). The dotted line defines the moment in time when the transition begins; precise details of execution are otherwise left to the discretion of the mandolinist.

STRUMMING THE STRINGS BEHIND THE NUT OR BEHIND THE BRIDGE



– strum the strings *behind the nut*, and strum the strings *behind the bridge*, respectively. In both cases, *all* eight strings are to be strummed, and should be permitted to ring on unimpeded. The direction and speed of arpeggiation, as well as the plucking position, are always indicated in conjunction with these symbols. Note that for strumming behind the nut, plucking-position instructions are always, *mutatis mutandis*, relative to the *nut*, instead of to the bridge as previously defined.

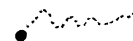
TRILLS



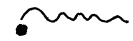
– *trill* with the left-hand fingers after plucking the primary note (the secondary note being indicated with a small notehead in parentheses). The *speed* of the trilling motion is suggested by the frequency of the triangular waveform contour. Articulation (either *legato* or *hammer/pull-off*) is always indicated in conjunction with these symbols.

PITCH-BENDING AND VIBRATO TECHNIQUES

Two types of *pitch-bend* and *vibrato* are employed in **Solar Dust: Orbits and Spirals**. Vibrato is generated simply through the repeated application of a pitch-bend technique.



– *kōtō* vibrato/pitch-bend: according to the given contour, depress and release the string(s) *behind the bridge* with the right-hand index finger (and/or other right-hand fingers), causing the pitch to fluctuate above the written note.




– *push* vibrato/pitch-bend: according to the given contour, push and release the string(s) *laterally* – i.e. parallel to the frets – with the left-hand finger(s), causing the pitch to fluctuate *slightly* above the written note. (The perceived pitch-fluctuation is less for this technique than for the *kōtō* vibrato/pitch-bend; however, the two techniques do vary in sound-quality and modulation characteristics.)


The waveform contours provide only an *approximate* indication of the frequency and amplitude of the required actions. The maximum amplitude of the given contour should

correspond directly to the maximum pitch-bend physically attainable in the musical context. Both techniques are applied to *single notes only* in **Solar Dust: Orbits and Spirals**.



PORTAMENTO

-  – *portamento*: slide the left-hand finger(s) along the fingerboard from one position to another, thereby allowing the pitch to (smoothly) rise or fall, as indicated. The *speed* of the sliding action is carried out according to the notated duration. *Articulation* – ‘legato’: *do not* pluck the terminal note of the portamento; or ‘tenuto’: conduct the sliding action and then pluck the terminal note of the portamento – is always indicated in conjunction with these symbols.

STRING MUFFLING

-  – *muffle* the string(s) *lightly* with the side or palm of the right hand (below the little finger), while simultaneously plucking. The resultant sound should still be quite resonant yet muted in quality, with a somewhat shorter decay-time than normal. As the piece moves to a close, the degree of muffling could progressively increase, attenuating the resonance even further (at the discretion of the mandolinist).

HARMONICS

-  – *natural harmonic*: on the specified open string(s), lightly touch the *node* (usually with a left-hand finger) at or near the fret corresponding to the pitch notated with a broken-diamond notehead, while plucking – in order to produce the harmonic sound. Natural harmonics must always be allowed to ring on.
-  – *artificial harmonic*: on the specified course, stop the string(s), normally, at the fret corresponding to the pitch given in parentheses, while lightly touching the node at or near the fret corresponding to the higher pitch notated with a broken-diamond notehead, and pluck, as for natural harmonics. Similarly, artificial harmonics must always be allowed to ring on as long as possible.


For *diamond noteheads with an “R” to the right of them*, the right-hand index finger will definitely be needed to lightly touch the specified node while plucking. In circumstances where the use of a left-hand finger to lightly touch the required node is unduly onerous, the right-hand index finger may be substituted – provided that the string(s) can be plucked adequately, and the resulting harmonic timbre is satisfactory.

Where applicable, alternative nodal (and stopping) positions upon the specified course may be substituted at the discretion of the mandolinist – subject, naturally, to the proviso that the same resultant pitch is elicited!

Specific *plucking positions* for harmonics are never requested herein, in order to encourage the mandolinist themselves to locate a plucking position that furnishes the *cleanest, most sonorous timbral quality* for each harmonic! (Occasionally, however, technical and physical constraints may restrict the ambit of choice for a harmonic’s plucking position.)

Note: Resultant pitches of harmonics are nowhere shown within the score itself.

BITONES

-  – *bitone*: on the specified course, stop the string(s) normally at the fret corresponding to the pitch notated with an oblong notehead, and pluck the string(s) between the stopping finger and the *nut*! Specific *plucking positions* for bitones are never requested herein, due to limitations imposed by technical and physical exigencies – although it can be said that it is generally easier and more successful to pluck the string(s) somewhat away from the stopping finger.

In references to pitch within the table below, “Middle C” shall be designated as C \sharp 3, the C \sharp one octave higher as C \sharp 4, etc.; \sharp denotes an intonation *approximately* a quartertone sharp from \flat .

The following bitones – shown with their projected resultant pitches (which are not given anywhere else within the score itself) – have been utilized in **Solar Dust: Orbits and Spirals**:

Course	Fingered pitch	Resultant bitone pitch
G \flat 2	E \flat 3	D \flat 4
G \flat 2	F \flat 3	B \sharp 3
G \flat 2	B \flat 3	F \sharp 3
D \flat 3	A \flat 3	B \sharp 4
D \flat 3	B \flat 3	A \flat 4
D \flat 3	E \flat 4	D \flat 4
A \flat 3	F \flat 4	E \flat 5
A \flat 3	G \sharp 4	B \sharp 4
E \flat 4	C \flat 5	B \flat 5

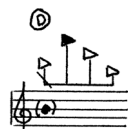
NB: Assuming that A \flat 3 = 440 Hz, then C \flat 3 \approx 261.6255653 Hz.

Note: Because mandolins’ actions can vary considerably from one instrument to another, resultant bitone pitches in practice might not correspond exactly to those predicted within the table above. Regardless of inaccuracies, however large (or small) any bitone pitch-discrepancies might be, the mandolinist whenever performing these bitones is *on no account ever* to attempt to ‘correct’ such deviations – should they occur – by selecting some other course or fret to stop: only those courses and conjunct fingered pitches specified herein may be engaged for the production of bitones throughout **Solar Dust: Orbits and Spirals**.

‘STRING DRUMMING’

‘*String drumming*’ appears to be a new mandolin technique (proposed by Adrian Hooper) in which the plectrum, instead of plucking as usual, ‘*drums*’ or strikes the string(s) from above according to the given rhythm and dynamic levels. The resultant percussive sonority modulates in response to variations in the left-hand stopping position (if applicable) as well as the exact spot where the plectrum ‘drums’ the string(s). (‘String drumming’ obviously may be applied to *open* courses – or even bitones – too.)

Note: It has been confirmed that 'drumming' string(s) with the *side* (i.e. the rounded edge) of the plectrum is far more efficacious than attempting to 'drum' string(s) with the plectrum's point.



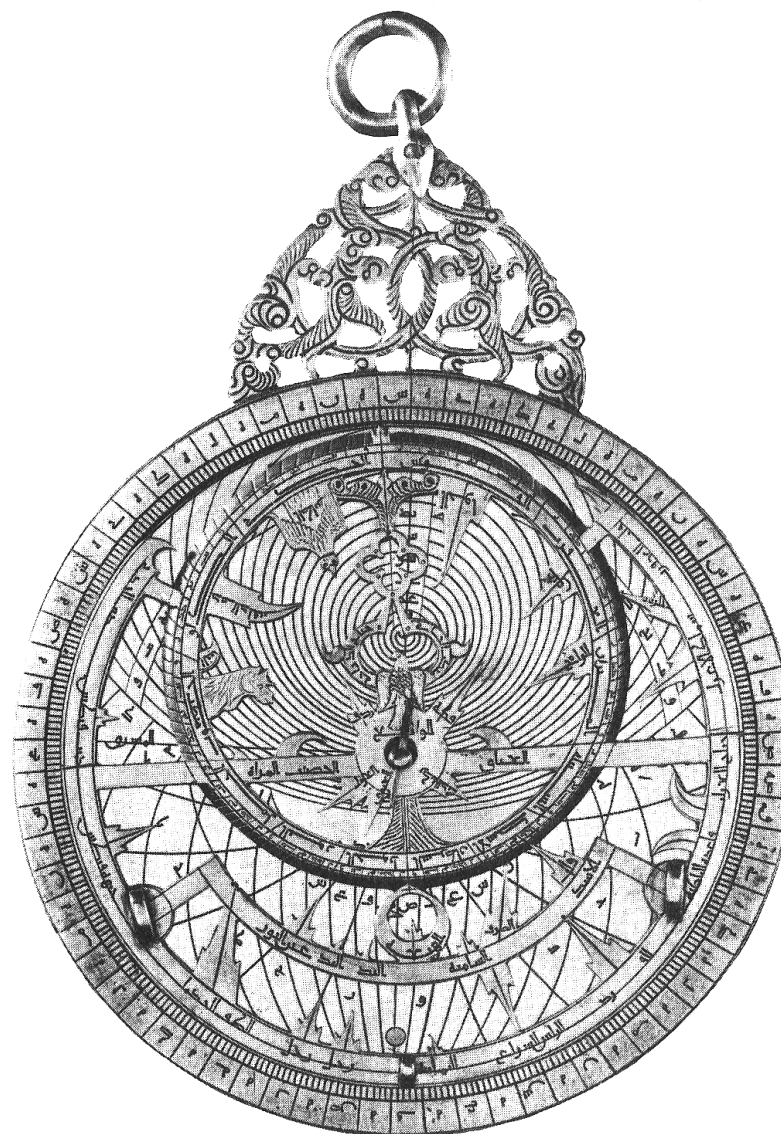
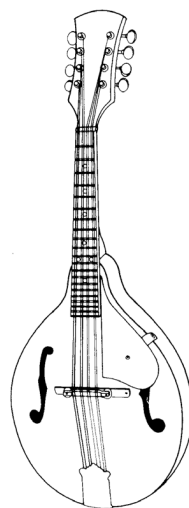
– 'drum' the string(s) *beyond the end of the fingerboard*: with the left hand, stop the string(s) normally (if applicable) on the specified course at the fret corresponding to the pitch given in parentheses, and 'drum' the string(s) beyond the end of the fingerboard. The 'drumming' spot is determined here according to the relative vertical locations of the wedge-shaped noteheads: a *blackened-in* wedge-shaped notehead denotes the highest practicable 'drumming' spot (*very* close to the bridge), whereas the lowest-placed open wedge-shaped notehead just above the staff denotes a 'drumming' spot very close to the end of the fingerboard (or even just upon it, for some mandolins).



– 'drum' the string(s) *upon the fingerboard*: with the left hand, stop the string(s) normally (if applicable) on the specified course at the fret corresponding to the pitch given in parentheses, and 'drum' the string(s) upon the fingerboard at the spot where a left-hand finger would stop the string(s) in order to produce the pitch indicated by the open wedge-shaped notehead.

The resonant percussive sonority which ensues from 'string drumming' a course contains two discernible pitches: a sustained 'drone tone' (the pitch notated in parentheses), and a brief, delicate and percussive 'strike tone' (the pitch notated with a wedge-shaped notehead when 'drumming' upon the fingerboard, or an indeterminate high pitch when 'drumming' beyond the end of the fingerboard). Here, the string-length between the 'drumming' spot and the bridge establishes the pitch of the 'strike tone'.

© Ian Shanahan, Sydney, Australia; 27 March 1988.



Solar Dust

Orbits and Spirals

Stone-like, hieratic and inexorable - but extremely sensitive to timbral, rhythmic and dynamic subtleties.

$\text{♩} = c.53.$

plenum
Pause until the sound is lost in the distance.
c.3"
A delicate.
f poss. mf 3:2 F pp p ppp fff: mf p pp p poss. f poss. mp 5:4 F p c.4"

$\text{♩} = c.98.$ Declamatory.
resonant.
G D E
Pause until the sound is lost in the distance.
finger
Timbre of the harmonics: as 'clean' as possible.
plenum
E
3:2 F
f poss. f mp mf ff
f poss.
3:2 F
f poss.
Quite fast: free, somewhat irregular durations (partly determined by technical exigencies).
G D A E G D A E G D A D A G
b R h R # R R
finger plenum b R
all harmonics: f poss...
brilliant, clear and starry - like cosmic dust.

Echo: rather regular, delicate and precise - with some degree of flexibility nevertheless.
D 17 attacks beyond the fingerboard...
D E G D A E D G A D A E
R R
finger plenum
do not pause.
p poss. ppp f poss. p poss. pp p f poss. ppp mp p pp ppp p f poss. p poss.
quicksilver!

Steadily slow down...
approximately 32 attacks...
do not pause.
A D E
c.70. Stone-like, hieratic...
quicksilver!
11 attacks beyond the fingerboard
etc...
f poss.: p poss. pp f poss. ff f 3:2 F p

$\text{♩} = c.70.$ Stone-like, hieratic...

accel...
very sensitive and careful.
mp p poss. f poss. fff f mp p ppp mp mf f f poss. ff mf f f poss. mp

finger
plectrum
Pause until the sound is lost in the distance.
finger
Pause until the dynamic level falls to 'mp'.

$\text{♩} = \text{c. } 98. \text{ Declamatory.}$

Rather regular and precise, as before - again with some degree of flexibility.

17 attacks beyond the fingerboard...
ppp very emphatic. f poss....
all harmonics: f poss....
Timbre of the harmonics: as 'clean' as possible.
do not pause.
c. 2"
do not pause.
c. 1"
quicksilver!
do not pause.
c. 3"
do not pause.
c. 2"

Very fast: free durations, but more regular than before.
quicksilver!
9 attacks beyond the fingerboard.
do not pause.
p f poss. p! f poss....
brilliant and glittering.
A D E D G E D G A D E G A D E G A G
finger plectrum
pause as little as possible.

$\text{♩} = \text{c. } 98. \text{ Stone-like, hieratic and inexorable.}$
Somewhat slower; declamatory and forceful - as precise as possible.
As fast and as violent as possible!
Echo.
do not pause. finger
p
very fuzzy, indistinct sound: always 'tremolo' as fast as possible.
c. 6" True portamento (no distinct semitones):
• with minimal pressure, slide the L.H. fingers down the fingerboard at the slowest rate such that the pitches fall in a smooth, continuous manner.
fff f mf f poss. ff stffz: mp p poss. mp fff...
3:2 F 5:4 F 3:2 F 5:4 F

----- Much noise, from both the plectrum and finger. -----

----- finger -----
----- plectrum -----

c. 10"

Dispel the tension!

c. 7"

do not pause.

≥ c. 3'30"

rall. trem. ----- / stop trem. -----

p poss.

mf p mp pp p PPP p mp pp f p ppp mf f p mp pp ppp: p mf

Very gradually and smoothly increase the tempo and tension. ----- AS FAST AND AS TENSE AS POSSIBLE! Push yourself and your instrument to the limit! -----

Repeat the material incessantly, for at most approximately 3 minutes!

(Tempo: ♩ ≥ c. 200.)†

Wild, ecstatic and vibrant - with extreme virtuosity and flair! TRY to maintain rhythmic accuracy WHEREVER POSSIBLE, if necessary sacrificing the given timbral details (precise plucking position, vibrato etc.). At any rate, the main objective here is to maximize excitement - so really "go for it"!

Continue to repeat the material incessantly, for at most approximately another 3 minutes!

c. 20"

≤ c. 3'...

Imperceptibly raise all dynamic levels. ----- all notes f poss.!

c. 0'45"...

Steadily decrease the tempo and tension. -----

Gradually lower the dynamic level. -----

----- (♩ ≤ c. 64.) -----

Very precise, calm, resonant and impersonal. A return is made to the material as stated initially.

Now also, for at most approximately 2 minutes, allow the rhythm to progressively degenerate and become imprecise, at the same time gradually transforming this material into the following final utterance:

≤ c. 2'...

----- (dynamics as given originally) -----

Infinitely slow, distant and calm: NO SENSE OF PULSE!

Place the notes approximately as given relative to one another...

mp p pp ppp p pp

finger plectrum

mp ppp p

mp pp p pp

ppp p ppp

pp

c. 4"

† At such high tempi, some rhythmic distortion together with performance errors such as wrong notes, incorrect techniques as well as various string and plectrum noises will surely occur. Do not worry unduly about this, and ABSOLUTELY do not lower the tempo: such 'mistakes' in moderation greatly enhance the piece!

Even slower! Yet more distant and muted...

Beautiful, mellow and clear: interrupting the process.

Continuing on...

Explosive!

Pause until the sound is lost in the distance.

$\text{♩} = c.53$. Hard, incisive and precise - but melting away...

do not arpeggiate the chord too slowly!

Pause until the dynamic level falls to 'pp'.

mp mellow, resonant.

Pause until the sound is lost in the distance.

Maintain your physical attitude: DO NOT MOVE!

Relax!

G.J. Shaw. 27 March 1988.
Sydney, AUSTRALIA.
Slight revisions 9 April 1999.

CHAPTER 3. ÉTUDES FOR SOLO RECORDER

3.1 FIVE ÉTUDES

3.1.1 ANALYTICAL NOTES

Beyond what I have already written within the Programme Annotations to each of my **Five Études** for solo recorder, little needs to be added here. I would, however, like to emphasize that these brief études are all directed at (young) student or amateur recorder-players who are unacquainted with late-twentieth-century recorder-playing techniques; the level of compositional intricacy I have brought to bear on these modest pieces is, therefore, appropriately low – though not without a certain degree of quirkiness, so that they might be adjudged as ‘simple’ by some, but never ‘simplistic’. With the exception of **Lingua Silens Florum** (which is a sinuous through-composed melody), the other four études all display clear-cut ternary forms – a unifying agent for this set of studies.

Helical Ribbon

Helical Ribbon is a fast ‘funk’ number that stylistically owes something to my dear friend and colleague Michael Smetanin’s multiple (contra)bass clarinet encore piece **Ladder of Escape** (1984): indeed, the rhythm in bar 3 from **Helical Ribbon** is taken straight out of Smetanin’s popular work – as a sign of my respect and affection towards him. The form-plan of **Helical Ribbon** is:

Section A: A₁ (bar 1 {antecedent} and bar 2 {consequent});
A₂ (bar 3);
A₃ (bars 4–5); A₃* (bars 6–7);
A₃ + A₃* truncated (bars 8–11);
A₂* (bar 12 {bridge});

Section B: B₁ (bar 13 {antecedent – x} and bar 14 {consequent – y});
x + y* (bars 15–16);
B₂ (bar 17);

Section A*: A₁ (bars 18–19);
A₂** (bar 20);
codetta (bars 21–22 {silence}).

(It is entirely by accident that the number of bars and multiphonic fingerings within this étude are identical.)

Lingua Silens Florum

The only additional point I wish to make about **Lingua Silens Florum** is that I made a conscious composerly decision to limit almost all of its alto recorder fingerings to those which are standard or very well known: any timbral- or pitch-inflections (some of which are only microtonal, others much greater) away from the expected sounds are wholly due to the end of the recorder's footjoint being shut airtight. I simply did not wish to overburden inexperienced recorder-players who might want to learn this *étude* with both unusual fingering-configurations and an unfamiliar, even capricious instrumental response brought about by such 'preparation'.

Cathy's Song

Beyond the cheerless context of its creation, as divulged within its Programme Annotation (and notwithstanding any polemics therein), **Cathy's Song** just grew out of an elementary idea: a C major triad (within an initial tonality¹ of G) alternates with a D major triad – both triads being arpeggiated in their second inversion (bars 1–5).

This piece then playfully winds its way through several scales, modalities and tonal centres,² often via common 'pivot tones', using an additive asymmetrical rhythmic language that is indebted to the musics of Olivier Messiaen and (perhaps) of various Eastern European folk traditions.

The form-plan of **Cathy's Song** is:

Section A: A₁ (bars 1–2 {G tonality}); A₁* (bars 3–4); A₁ (bar 5 – a slight variant of bar 2);
A₂ (bar 6 {E_b whole-tone ♯6}); A₂* (bar 7);
A₃ (bars 8–9 {D lydian});
A₄ (bars 10–11 {D dorian; bridge});

Section B: B₁ (bars 12–14 {B_b lydian});
B₂ (bars 15–16 {C mixolydian});
B₃ (bars 17–18); B₃* (bars 19–21);
B₁* (bars 22–24 {F lydian to whole-tone to chromatic});
B₄ (bars 25–26 {B_b neapolitan minor to lydian});
B₃** (bars 27–30 {C mixolydian});
B₅ (bars 31–34 {E aeolian # 3});
B₆ (bars 35–39 {F aeolian to whole-tone; bridge});

Section A*: A₁ + A₁* (bars 40–42 {G tonality}); A₁ (bar 43 – as bar 5);
A₂** (bar 44 {F whole-tone ♯6} – transposed variant of bar 6);
A₂* (bar 45 {E_b whole-tone ♯6});
A₃* (bars 46–47 {D lydian});
A₄* (bars 10–11 {D dorian to C tonality});
codetta (bars 51–52 {C lydian ♭6 to silence}).

Dysfunctional Habañera

Dysfunctional Habañera is unified by the fact that the pitch-contents of each one of its bars always emanate from a single fingering-pattern, different tones within a bar belonging to distinct registers. Indeed, it is the consideration of register that allows one to discriminate between material from section A or from section B: pitches within any given bar from section B are separated by some interval smaller than a perfect fourth; these tones invariably fall within the alto recorder's first or second registers. (The fingerings behind such pitches could be chosen as the initial ingredients of the sorts of flickering 'fractalous sonorities' found in the recorder parts of **Lines of Light: Seven Improvisations on αιθερος μελος**, **Zodiac: Crystal Orbit Improvisations** and **[p]s(t)ellor/mnême**.)

The form-plan of **Dysfunctional Habañera** is:

Section A: A₁ (bar 1);

Section B: B₁ (bars 2–3 {antecedent + consequent}); B₁^{*} (bars 4–5 {antecedent + consequent});
B₂ (bars 6–7 {antecedent + consequent}); B₂^{*} (bars 8–9 {antecedent + consequent});

Section A*: A₂ (bar 10);
A₁ (bar 11);
codetta (bar 12 {silence}).

NB: In Section B, there are three architectonic levels of antecedents + consequents: single pairs of bars (e.g. bars 2 and 3), pairs of pairs of bars (e.g. B₂ and B₂^{*}), and pairs of four-bar groups (B₁ + B₁^{*} and B₂ + B₂^{*}). This is, of course, a typically 'Classical' construct.

Graeme Petrie, scallywag

In many ways, **Graeme Petrie, scallywag** is certainly a technical and conceptual simplification of **Helical Ribbon**: several alto recorder multiphonics are common to both études, which display the same kinds of unsophisticated repetitiousness and straightforward ternary infrastructure. Some eyebrows, however, might well be raised at the small note-values within **Graeme Petrie, scallywag**:

Attitudes can be set in advance by a suitable choice of notation – unwelcome associations can be avoided, affiliation declared. Teachers know that the sight of a page of semiquavers can send the learner into a nervous rigor, and that it is good practice to notate children's pieces in crotchets and quavers, avoiding the terror-inspiring double beams.* * [footnote] In the seventeenth century, the theorist Georg Muffat was already warning performers against *horror fusae* – the alarm caused by the sight of double fusae (semiquavers).³

Yet, as one aspect of winning mastery over **Graeme Petrie, scallywag**, it is precisely because of the need of so many relatively unskilled recorder-players to conquer their fear of what they see before them and so overcome this so-called *horror fusae* that I decided in

the end to notate **Graeme Petrie, scallywag** with a quaver tactus which is often subdivided into semiquavers or demisemiquavers.

The form-plan of **Graeme Petrie, scallywag** is:

Section A: A_1 (bar 1 {antecedent – i} and bar 2 {consequent – j});
 $i + j^*$ (bars 3–4);

Section B: B_1 (bar 5 {antecedent – k} and bar 6 {consequent – l});
 $k + l^*$ (bars 7–8 [the multiphonics in l^* reverse the order of those in l]);

Section A*: i^* (bar 9);
codetta (bars 10–11 {decelerating trills}).

Annexe: The Compact-Disc Programme Annotation for Five Études

My Programme Annotation for **Five Études** that is given below was originally published within the booklets accompanying the locally produced Compact Discs “Echoes/Fantasies” (Broad Music Records Jade JADCD–1088, released in March 2000) and “Fray” (Broad Music Records Jade JADCD–1086, released in July 1999):

These five études are unique in my *œuvre*: they are all deliberately straightforward (being composed for adventurous young recorder-players), and each concentrates upon a quite narrow technical region. **Helical Ribbon**, a multiphonic study in funk, is dedicated to Warren Burt. **Lingua Silens Florum** was written for Professor Eric Gross, on his retirement from the University of Sydney; it requires considerable breath- and articulatory-control, since the recorder’s endhole is blocked airtight. **Cathy’s Song** is a compact study in agility and asymmetric rhythm. **Dysfunctional Habañera**, respectfully offered to Dulcie Holland, calls for just one fingering-pattern per bar: different pitches are obtained by regulating air-flow and articulation. **Graeme Petrie, scallywag** (this Debussyesque title being a wink at one of my mischievous students) is another simple exercise in multiphonics – rather cheeky and insouciant, exactly like its namesake.

ENDNOTES

1. Hannan (1982), p.207 n.17: "The term "tonicality" was adopted by Lloyd Hibberd ("Tonality and Related Problems of Terminology", **Music Review**, 22 (1961), 13) as a useful term for musical contexts with strong indications of tonal centring (the feeling of a "tonic") but with no indication of the concept of "key" and its associated harmonic vocabulary. "Tonicality" was suggested by Reti as a possible source of the term "tonality" (**Tonality Atonality Pantonality** (London, 1958)). Hibberd sees tonicality as an authentic term for a concept which later (through the term "tonality") took on a more specialized meaning".
2. For a deeper knowledge of scale-formations, see Persichetti (1962), pp.31–65.
3. Cole (1974), p.29.

Ian Shanahan (1988–1991)

– *To Warren Burt, Dr Eric Gross, ‘CS’, Dulcie Holland, and Graeme Petrie*

For adventurous recorder-players:

~~~~~

# *Five Études*

for

solo recorder

~~~~~

1. ***Helical Ribbon*** (1990),
a terse étude
for alto recorder.

2. ***Lingua Silens Florum*** (3.6.1991),
a garland
for prepared alto recorder.

3. ***Cathy's Song*** (3.4.1988),
an encore piece
for sopranino (or alto) recorder.

4. ***Dysfunctional Habañera*** (1990),
for alto recorder.

5. ***Graeme Petrie, scallywag*** (1990),
for alto recorder.

PROGRAMME ANNOTATIONS

Five Études

for solo recorder

Ian Shanahan (1988–1991)

These five miniature studies, each lasting less than a minute, focus upon particular aspects of contemporary recorder technique. However, beyond serving merely a didactic or pedagogical function, I also envisaged them as being (hopefully) rather effective individual encore pieces, or brief, but eye-opening, 'fillers' – taken either alone, or collectively – between more substantial musical items.

1. *Helical Ribbon* (1990), a terse étude for alto recorder.

This unassuming and innocuous little piece is respectfully dedicated to my esteemed colleague Warren Burt, a singular individual and composer from Melbourne who works tirelessly for the cause of new music. It was written specifically for the occasion of him being presented with a "Sounds Australian Award" in April 1990. The one-page original manuscript – and my world première performance – of **Helical Ribbon** was his prize!

Consequently, this piece embraces several features that are perhaps representative of Warren's composeserly predilections, aesthetics and philosophies (as well as my own): scientific cross-references and applied paradigms, unique microtonal structures, and 'funk'. For instance, the "Helical" of my title provides a conceptual metaphor, only vaguely mirrored in the music, alluding to the distinctive double spiral/helix construction of the deoxyribosenucleic acid (DNA) molecule, human life's building-block; the 22 microtonal sonorities that almost entirely comprise the work are paragons of vertical dimensionality from the recorder's multiphonic sound-world, and so justify acoustically the title's "Ribbon" (instead of a linear, uni-dimensional monodic 'curve', typical of the recorder's conventional repertoire), at the same time obliquely referring to Warren's entry within John Jenkins' recent and important book **22 Australian Composers**.

Helical Ribbon, less than a minute in duration, serves a dual musical function – both as a deliberately shocking yet straightforward encore piece (to follow a concert of more traditional concert music), and as a pithy, rather challenging technical study for adventurous recorder-players who wish to become acquainted with the vast multiphonic capabilities of the alto recorder.

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2. *Lingua Silens Florum* (3.6.1991), a garland for prepared alto recorder.

"It is said that the Buddha once gave a sermon without saying a word;
he merely held up a flower to his listeners.
This was the famous 'Flower Sermon',
a sermon in the language of patterns,
the *silent language of flowers*."

György Doczi, **The Power of Limits**, p.1.

This very brief and gentle work (in which the alto recorder is 'prepared' by blocking the instrument's endhole airtight with Blutac) is dedicated to Dr Eric Gross, upon his retirement

from the position of Associate Professor in the Department of Music at the University of Sydney. I premièred it at his Farewell Concert, as the first of a number of short 'garlands' in a musical Festschrift offered to the esteemed professor. Besides being just an exercise in breath- and articulatory-control, one hopes that the subtle floral patterning of the music in **Lingua Silens Florum** transcends mundanity, and captures something of the essence of the man.

© Ian Shanahan, Sydney, Australia; 3 June 1991.

3. *Cathy's Song* (3.4.1988), an encore piece for sopranino (or alto) recorder.

This vignette is totally atypical of my compositional output! At the time it was written (over a period of about four hours during the early morning of 3 April 1988 [Easter Sunday], whilst I was rather inebriated and thoroughly miserable), I recall feeling an illogical but ineluctable concern – alcohol-induced paranoia? – that I had lost the ability to write truly tuneful music ... something I have always been readily able to do, but by choice do not normally indulge in. (I also wanted to prove a point [to certain musical reactionaries]: that *at least some composers who write music which is not overtly 'melodic' do so not just because they are incapable of composing 'a decent tune'*.) Anyway, the outcome of this unhappy state was a very brisk, joyful, and bubbly little melodic piece, about one minute long, which contains quite a few quirkish rhythmic and modal twists (in the manner of Ross Edwards' fashionable *maninya* style, only much more so?). I do trust that **Cathy's Song**'s idiosyncratic attributes lift it beyond mere conservatism, which is something that I would hate to be accused of! I myself normally play **Cathy's Song** from memory, as a fun encore piece, but this isn't obligatory. At one level, this title makes reference to a vaguely similar tune by that wonderful Australian jazz composer and vibraphonist John Sangster, **Kaffir Song** – but there are private, more personal, connotations...

© Ian Shanahan, Sydney, Australia; 17 September 1989.

4. *Dysfunctional Habañera* (1990), for alto recorder.

5. *Graeme Petrie, scallywag* (1990), for alto recorder.

Way back in 1990, my friend Benjamin Thorn asked me to compose two little recorder pieces ("Two Brief Studies"), each concentrating on just one technique – but "not too difficult, please!" – for inclusion in the second volume of the Currency Press series **Recorders at Large**, edited by Ben. (Alas, I guess that I failed his 'easiness prerequisite', since neither composition surfaced within this anthology – although I tried so hard to be 'amateur-friendly', really I did, sir...; hence the manuscripts of these two hitherto-unnamed studies have been accumulating dust on top of my filing cabinet ever since!)

Anyhow, **Dysfunctional Habañera** is dedicated to the venerable Australian composer (and quondam recorder-player) Dulcie Holland – who is anything but dysfunctional! This conferment is a mark of my affection and respect for Dulcie; therefore, my miniature's musical language lies not too far from her own (notwithstanding my microtonality). If, by the way, you are wondering why this piece carries the sobriquet '*dysfunctional* habañera' ... then try dancing a proper habañera to it! There is, moreover, a kind of rhythmic hesitancy within its feel – due, perhaps, to the inertial, slightly sluggish response of its microtonal pitch-sets, which have all been generated by weird static fingerings (only one fingering-configuration is allotted per bar!).

When I became a member of staff in the Music Department at the University of Western Sydney (Nepean) during February 1996, it was my distinct pleasure to encounter

Graeme Petrie, who is one of the department's more interesting undergraduate students. Although it cannot be said that Graeme shines academically, he is nonetheless a real 'character', a bit of a larrikin – full of life, musicality and mischief, a talented trumpet-playing libidinous slightly bibulous hoon! (He is simply too likeable ever to chastise severely – even when he truly deserves it... Graeme just makes my job in academe that much more *enjoyable*, so no prizes for guessing who this miniature's dedicatee is!) My quaint title here is obviously a play on the name of Claude Debussy's comical cake-walk from Book II of his piano **Préludes: Général Lavine—Eccentric**. The cheeky, insouciant multiphonic sound-milieu of my little recorder étude just encapsulates Monsieur Petrie's personality so well in my mind that I could not resist designating it **Graeme Petrie, scallywag**. (*En passant*, Graeme must polish the roof of my old Holden Kingswood sedan before he graduates, for reasons I shan't go into here...)

© Ian Shanahan, Sydney, Australia; 19 January 1999.

Helical Ribbon, commissioned by the Australian Music Centre [Sounds Australian], was premièred by Ian Shanahan during the Sounds Australian Awards Presentation Night, the Sydney Dance Company Space, Pier One, Hickson Road, Walsh Bay, Sydney, on 11 April 1990. **Lingua Silens Florum**, commissioned by the Music Department of the University of Sydney, was premièred by Ian Shanahan during the Eric Gross Farewell Concert, the Everest Theatre, Seymour Centre, the University of Sydney, on 8 August 1991. **Cathy's Song** was performed by Ian Shanahan during "Recorders Unlimited", a concert held at The Old Darlington School, the University of Sydney, on 8 December 1989.

Recordings of **Helical Ribbon**, **Lingua Silens Florum**, **Cathy's Song**, **Dysfunctional Habañera**, and **Graeme Petrie, scallywag**, all played by the composer, are now commercially available on the Compact Disc "Echoes/Fantasies" (Broad Music Records Jade JAD CD 1088).

Heavily edited computer-generated scores of **Helical Ribbon** and **Cathy's Song** were published within the anthology "Recorders at Large, Volume 2" (ed. Benjamin Thorn), Currency Press [ISBN 086819-439-5], Sydney, 1995. A computer-generated score of **Lingua Silens Florum** has been published by Red House Editions (Edition No. RH 938), Footscray, VIC, Australia.

PERFORMANCE NOTES

1. **HELICAL RIBBON** (1990), A TERSE ÉTUDE FOR ALTO RECORDER.

PREAMBLE

In addition to its didactic/pedagogical purpose, this rather brief work might also be useful as a *genuinely surprising* encore piece after a primarily traditional recorder recital (incorporating the usual Early Music repertoire) – in which case it really ought to be performed from memory. **Helical Ribbon** is not as terrifying as it looks on first appearance! Whilst some memorization will indeed be necessary, internal repetitions of chains of multiphonics – all of which are numbered within the score, as a mnemonic aid – eases this task. In this regard, the recorder-player is encouraged to discover the piece's structure, prior to attempting rehearsal of it. Then ... I suggest that the fingerings be practised in sequence (temporarily ignoring the rhythms). Once all fingering-patterns have been corporealized and are completely natural for the executant, **Helical Ribbon** can then be learnt in the usual ways.

ARTICULATION AND RHYTHM

All articulation – *legato*, *tenuto*, *mezzo staccato*, *staccato*, etc. – should be strictly observed. The following special articulations are also utilized in **Helical Ribbon**:

× – *fingerslap solo*. Articulate with fingers only! Do not blow into the recorder. Slap the left-hand index finger down as hard as possible onto its fingerhole (as designated by the × in the tablature pictograph). Such an action yields a delicate percussive sonority, clearly pitched as indicated.

×
● – *fingerslap + blowing*. Using exactly the same vigorous finger-action as described above, blow into the recorder normally, thereby producing the multiphonic as well.

5
└ – *lateral lamino-palatal tongue-click, unvoiced*. A strong (partial) vacuum is created between the blade of the tongue and the hard palate. Release it laterally (with the side of the tongue), as loudly and as forcefully as possible. Such a tongue-click yields a sound that is sometimes used for encouraging horses.

✱ – *tongue-tremolo*. Articulate, as *quickly and as evenly as possible*, the (double-tonguing) phonemes '[d]idlidlidlidlidl...' – as in "fiddle".

✱ – *fluttersonguing*. A 'trilling' of the tongue-tip against the alveolar ridge.

All rhythms must be played precisely, with a very 'funky' feel.

MULTIPHONIC FINGERINGS AND DYNAMICS

Multiphonic research for **Helical Ribbon** was carried out upon an ebony Moeck Rottenburgh alto recorder. *All* multiphonic fingerings provided within the score are to be strictly adhered to: absolutely *no* modifications of fingering are permitted! (For multiphonics 16, 17 and 19 though, a very slight shading of the left-hand middle fingerhole – as shown within their tablature pictographs – is permissible, in order to facilitate reliable and rapid multiphonic production.)

Unless otherwise specified, dynamic levels are unambiguously defined by the breath-requirements necessary to generate the multiphonics such that their constituent pitches

are evenly balanced.

MICROTONES

The twenty-two alto recorder multiphonics employed within **Helical Ribbon** (as well as their resultant combination tones) define a unique micro-intervallic pitch-set, which will naturally be transformed whenever these multiphonics are performed – with the given fixed fingerings – upon any alto recorders that encompass different structural characteristics. The following symbology for *microtones* is employed in **Helical Ribbon**:

‡ and † denote a *quartertone above* ♯, and a *quartertone below* ♭, respectively. Arrowheads upon any accidentals denote slight intonational deviations – up to about an eighthtone – in the given direction.

VIBRATO

If used at all in **Helical Ribbon**, vibrato (in particular, air-column vibrato) is to be employed very sparingly, with discretion and 'good taste'.

Enjoy yourself, and good luck!

© Ian Shanahan, Sydney, Australia; 20 March 1990.

2. **LINGUA SILENS FLORUM** (3.6.1991), A GARLAND FOR PREPARED ALTO RECORDER.

PREAMBLE

This rather brief étude (duration: approximately 50 seconds!) is dedicated to Dr Eric Gross, Associate Professor of Music at the University of Sydney, upon his retirement. Aside from its rôle as a Festschrift 'garland' offering, **Lingua Silens Florum** fulfils a didactic purpose, and so may function as a study for student recorder-players – an exercise in breath- and articulatory-control. (It might even be useful as an encore piece, in which case it really should be performed from memory.)

PREPARATION OF THE ALTO RECORDER

It is imperative that the bore's endpoint, at the footjoint's endhole, be closed *absolutely airtight* for the duration of the work. I recommend the adhesion of a flat lozenge of "Blutac", "Bostik", "Plasticine", or some other malleable gummy substance to the bell, covering over the endhole completely. Such a preparation modifies the timbral, dynamic, and intonational response of the instrument; pitches somewhat below the alto recorder's regular gamut may be generated as well.

AMPLIFICATION

Because the alto recorder's dynamic level is greatly attenuated on account of its preparation, some sound-reinforcement, with a high-quality cardioid or omnidirectional air microphone, may be obligatory in performance spaces that demand considerable degrees of sonic projection. However, amplification must always be kept to a minimum, and in any case ought to be as 'natural'-sounding as possible: the delicate ambience of **Lingua Silens Florum** must be preserved.

FINGERINGS AND DYNAMICS

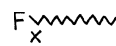
Research of fingering-resources for **Lingua Silens Florum** was carried out upon an ebony Moeck Rottenburgh alto recorder, prepared as described above. Every fingering-indication provided within the score is to be strictly adhered to: any modifications of fingering are outlawed! Pitches without tablature pictographs beneath the stave are to be played with their standard fingerings (only), unless an obvious repetitive pattern exists – in which case the fingerings are designated through circled numerical references to previous fingerings. To a large extent, each tone's dynamic level is circumscribed by the prevailing fingerings. Otherwise, dynamic nuances are left to the discretion of the recorder-player.

MICROTONES

The following symbology for *microtones* is employed in **Lingua Silens Florum**:

♯ and ♭ denote a *quartertone above* ♮, and a *quartertone below* ♮, respectively. Arrowheads upon any accidentals denote slight intonational deviations – up to about an eighthtone – in the given direction.

FINGERVIBRATO, AND VIBRATO IN GENERAL

F  denotes a *fingervibrato* with *fingerslapping* (repeatedly slapping the indicated finger down, as hard as possible, onto its fingerhole). Its fingering- and trilling-action are specified by the tablature pictograph below the stave.

Other varieties of vibrato – in particular, air-column vibrato – are to be employed very sparingly, with discretion and 'good taste'. Beyond the caesura (comma) *all vibrato is expressly forbidden!*

ARTICULATION AND RHYTHM

All articulation – *legato*, *tenuto*, *mezzo staccato*, *staccato*, etc. – should be strictly observed. Rhythms must be played precisely (but not mechanically).

GRACE NOTES

Grace notes lie 'outside time'. They should be executed quite quickly, but not too fast.

BREATHING AND PAUSES

Breathing should be accomplished as furtively and as efficiently as possible. The comma denotes a slight caesura, not necessarily for the purpose of taking a breath.

THE CLOSING MULTIPHONIC

The final multiphonic – gentle and fuzzy – should embrace both constituent tones in a fairly well-balanced fashion (as shown by the horizontal line contour), without the slightest hint of a wobble. It is secured merely by augmenting the breath-pressure, *carefully*, beyond that required for the previous low tone. Do not sustain it too long!

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
3. CATHY'S SONG (3.4.1988), AN ENCORE PIECE FOR SOPRANINO (OR ALTO) RECORDER.

PREAMBLE

Cathy's Song is intended to be used primarily as an encore piece after a concert performance. In such a context, it should ideally be played *from memory*, without the printed music! Alternatively, since **Cathy's Song** is not exceedingly difficult, it is suitable for public performance by competent recorder-players of any age. There are, however, various technical demands that the piece makes upon the recorder-player, particularly in relation to breath-control, fingering, articulation and rhythm. When **Cathy's Song** has been mastered, both technically and musically, the interpreter might then begin to think of themselves as being a good recorder-player! **Cathy's Song** is to be performed on either a *sopranino recorder* or an *alto recorder* – though personally, I much prefer to play this piece (and to hear it) on the sopranino. Furthermore, I find that the piece is not particularly well-suited to the sound of the soprano recorder, so I request that you do *not* play it on that size of instrument! (This injunction may encourage a reluctant amateur recorder-player to sharpen their technical and [sight-]reading skills on the F instruments of the recorder family.) I have included within the score of **Cathy's Song** a couple of alternative fingerings that the amateur recorder-player might find useful. Here are some further technical and interpretative remarks:

ARTICULATION AND RHYTHM


Articulations are to be more-or-less strictly adhered to in **Cathy's Song**. Likewise, all rhythms herein must be played *precisely* (but not mechanically: *feel it!*). Dynamics on the other hand are largely at the discretion of the recorder-player!

- – *tenuto*: sustain the note for its full duration, without any additional accentuation.
-  – *diaphragm thrust*: without *tonguing*, accentuate the note's attack by aspirating air into the instrument with a jolt or thrust from the diaphragm (but not so much as to cause the note to overblow into a higher register).

BREATHING AND PAUSES

- ◌ – *comma*: take a breath (*short pause*).
- (◌) – *parenthesized comma*: take a breath if necessary. Breath may be drawn in, as furtively and as efficiently as possible, at other phraseologically and structurally appropriate places in the music, as necessary – but do please breathe as little as possible!

PORTAMENTO

-  – *portamento*: connect the two pitches smoothly and (more-or-less) continuously by *sliding* the appropriate finger sideways *across* its fingerhole. The duration of this gliding action corresponds approximately to the initial rhythmic value. (NB: the final portamento of **Cathy's Song** is *optional*.) At any rate, the effect is *never* to be exaggerated.

Good luck, and enjoy yourself!

© Ian Shanahan, Sydney, Australia; 17 September 1989.

4. DYSFUNCTIONAL HABAÑERA (1990), FOR ALTO RECORDER.

ARTICULATION AND RHYTHM

All articulation – *legato*, *tenuto*, *mezzo staccato*, *staccato*, etc. – should be strictly observed. Rhythms must be played precisely, but habañera-like.

FINGERINGS AND DYNAMICS

Research of fingering-resources for **Dysfunctional Habañera** was carried out upon an ebony Moeck Rottenburgh alto recorder. Every fingering-indication provided within the score is to be strictly adhered to: any modifications of fingering are outlawed! Each fingering is to be *held constant* until the next fingering-configuration is provided (at the beginning of the next bar). Within each bar, the different pitches are obtained purely through the exercising of articulatory- and breath-control! To a large extent, each pitch's dynamic level is circumscribed by the prevailing fingering.

MICROTONES

The following symbology for *microtones* is employed in **Dysfunctional Habañera**:

‡ and † denote a *quartertone above* ♭, and a *quartertone below* ♭, respectively.
Arrowheads upon any accidentals denote slight intonational deviations – up to about an eighthtone – in the given direction.

BREATHING AND PAUSES

Breathing should be accomplished as furtively and as efficiently as possible. The comma denotes a slight caesura, not necessarily for the purpose of taking a breath.

Enjoy yourself!

© Ian Shanahan, Sydney, Australia; 19 January 1999.

5. GRAEME PETRIE, SCALLYWAG (1990), FOR ALTO RECORDER.

ARTICULATION AND RHYTHM

All articulation – *legato*, *tenuto*, *mezzo staccato*, *staccato*, etc. – should be strictly observed. Rhythms must be played *precisely*, but “flowing easily”.

MULTIPHONIC FINGERINGS AND DYNAMICS

Multiphonic research for **Graeme Petrie, scallywag** was carried out upon an ebony Moeck Rottenburgh alto recorder. *All* multiphonic fingerings provided within the score are to be strictly adhered to: absolutely *no* modifications of fingering are permitted!

Unless otherwise specified, dynamic levels are unambiguously defined by the breath-requirements necessary to generate the multiphonics such that their component tones are *equally balanced*.

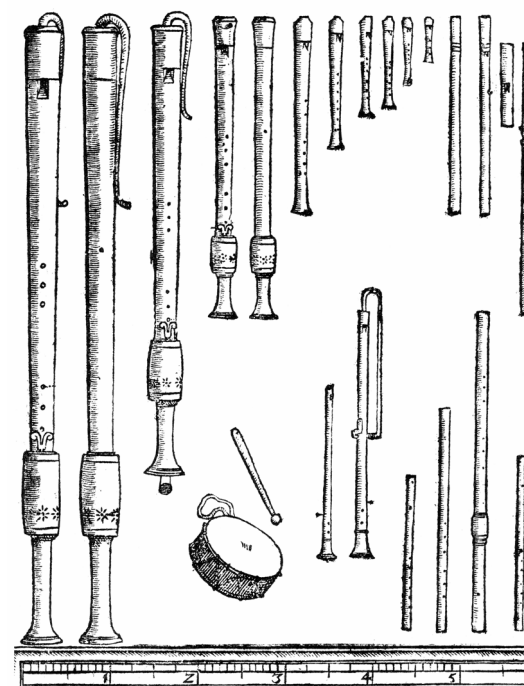
MICROTONES

The fourteen alto recorder multiphonics employed within **Graeme Petrie, scallywag** (as well as their resultant combination tones) define a unique micro-intervallic pitch-set, which will naturally be transformed whenever these multiphonics are performed – with the given fixed fingerings – upon any alto recorders that encompass different structural characteristics. The following symbology for *microtones* is employed in **Graeme Petrie, scallywag**:

‡ and † denote a *quartertone above* ♭, and a *quartertone below* ♭, respectively.
Arrowheads upon any accidentals denote slight intonational deviations – up to about an eighthtone – in the given direction.

Have fun!

© Ian Shanahan, Sydney, Australia; 19 January 1999.



Helical Ribbon

Respectfully offered to WARREN BURT,
on receiving a well-deserved Sounds
Australian Award.

♩ = c. 140 (or more). Really funky, rhythmic, energetic: always driving forward.

Handwritten musical score for guitar, featuring four systems of music. Each system consists of a staff with notes and a corresponding fretboard diagram below it. The score includes various musical notations such as accidentals, dynamics (f, p), and articulation marks (accents, slurs). The fretboard diagrams show fingerings and positions on the strings.

System 1: Measures 1-8. Includes a first ending bracket over measures 7 and 8.

System 2: Measures 9-15. Includes a first ending bracket over measures 14 and 15.

System 3: Measures 16-22. Includes a first ending bracket over measures 21 and 22.

System 4: Measures 23-29. Includes a first ending bracket over measures 28 and 29.

Additional markings include "f poss." (forte possible) and "echo (p)" (echo piano) in measures 14, 15, 21, 22, 28, and 29.

At the bottom left, the word "Raunchy!" is written above measures 16 and 17.

The fretboard diagrams are numbered 1 through 29, corresponding to the measures.

Beginning again ...

Handwritten musical score for a multi-phonics exercise, measures 16 through 21. The score is written on a grand staff (treble and bass clefs) with various musical notations including notes, rests, and dynamic markings. Below the staff, fingerings are indicated by numbers 1-5. Performance instructions are written in the right margin.

Measure 16: *echo (p)*

Measure 17: *f poss.*

Measure 18: *a brief, random mixture of tongue-tremolo and fluttertonguing.*

Measure 19: *breath-flow: absolutely steady.*

Measure 20: *(terminate the multiphonic cleanly.)*

Measure 21: *poco*

Maintain your physical attitude: do not move!

(Now relax...)

Handwritten musical score for measure 22, ending with a double bar line and the word "FINE". The score is written on a grand staff. Below the staff, fingerings are indicated by numbers 1-5. The word "FINE" is written in large, bold letters.

Measure 22: *FINE.*

Signature: *S. Shostakovich*

Date: *Sydney, AUSTRALIA. 3 March, 1990.*

THE 22 MULTIPHONICS - in order of appearance.

Handwritten musical score showing the 22 multiphonics in order of appearance. The score is written on a grand staff with notes and rests. Below the staff, fingerings are indicated by numbers 1-5.

Measure 1: *1*

Measure 2: *2*

Measure 3: *3*

Measure 4: *4*

Measure 5: *5*

Measure 6: *6*

Measure 7: *7*

Measure 8: *8*

Measure 9: *9*

Measure 10: *10*

Measure 11: *11*

Measure 12: *12*

Measure 13: *13*

Measure 14: *14*

Measure 15: *15*

Measure 16: *16*

Measure 17: *17*

Measure 18: *18*

Measure 19: *19*

Measure 20: *20*

Measure 21: *21*

Measure 22: *22*

Lingua Silens Florum

♩ = c. 77. Plaintive, distant, mysterious: soft and delicate, but expressive.

1. Prepared: end of footjoint closed airtight (■).

5. 5:4 F, 3:2 F, 3:2 F, 5:4 F, 3:2 F

10. 3, 3, 3, 3, 4, 5

14. 4, 5, 4, 5, 4, 5

FINE. c. 50''

Sydney, AUSTRALIA. 3 June, 1991.

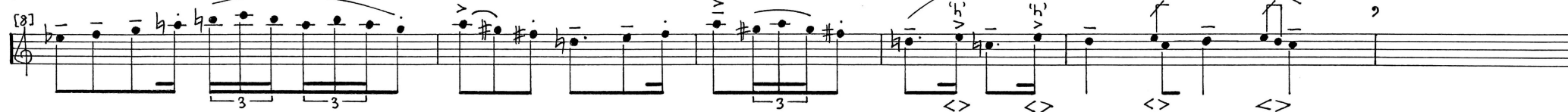
Cathy's Song

Quite fast, joyous and full of life! ♩ = c. 141 [♩. = c. 94].

1. Impish.



7.



Tempo as before (or a bit faster), with added energy.

12.



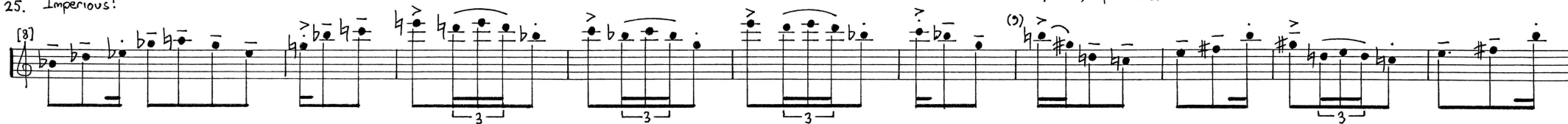
18.



25. Imperious!

Exuberant!

Lyrical, expressive.



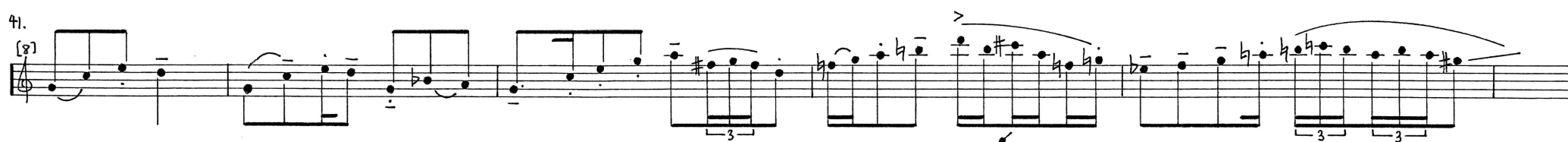
Hold back ----- // Tempo I.

35.

Impish.



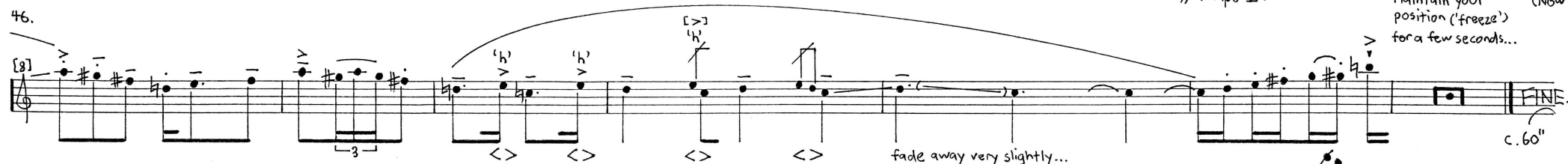
41.



Hold back ----- // Tempo I.

46.

Maintain your position ('freeze') for a few seconds... (Now relax...)



J. I. Shuman

Sydney, AUSTRALIA. 3.25 - 7.00 a.m., 3 April, 1988 [Easter Sunday] - No sleep again! (And misery.)

Dysfunctional Habañera

Habañera-like. ♩ = c. 65-74.

slow down a bit. -----

1. **2/4** **3/4**

mp f mp pp... p... pp...

-----slightly slower.

6. **2/4** **3/4** **5/8**

p... pp... p... mf p

original tempo...

10. **5/8** **2/4**

mp f mp f mp

Be still!

FINE. c. 30"

I. L. Shanahan
Sydney, AUSTRALIA. 1990.

Graeme Petrie, scallywag

Flowing easily: cheeky! ♩ = c. 60.

10.

CHAPTER 4. ASTRONOMICAL METAPHORS: PRECESSIONAL TIME-CYCLES AND ENTROPY ...

4.1 CYCLES OF VEGA

4.1.1 FURTHER REMARKS

Almost all of the numerous ‘analytical insights’ that I am content to divulge concerning **Cycles of Vega** are congregated within Chapter 1; there is indeed little else for me to add here about this piece. And yet one idea (of rather provincial interest) does remain to be illuminated momentarily – it is an aspect of **Cycles of Vega**’s rhythmic idiolect.

In section 1.2.2, those isorhythms underpinning each of **Cycles of Vega**’s three sections were introduced in detail; these repetitive time-cycles all embrace two or more rhythmic lines, giving rise, on occasion, to an amusing compositional problem: How is one to deal with a situation where three (or so) attacks across these isorhythmic tiers all coincide? My musical solution was simply to diffract such conjunctions – either by inserting grace-notes, or by delaying some of the strata’s attacks slightly.¹ Naturally, such dispersive tactics may well render the isorhythms’ permutative patterns and innate cyclicity somewhat ambiguous, but nonetheless, I do insist that their effect is beneficial musically ... an enrichment of rhythm.

Whenever various compositional trajectories, or curves of energy, happen to converge in **Cycles of Vega** – fast tempi (within an ongoing tempo-glissando); a kaleidoscopic aggregation of percussion timbres; the need to preserve isorhythms or *isochromata*, for example – then performative predicaments could mount up. My means of bypassing such technical emergencies, while injecting some degree of microformal irregularity, was to institute, within my metrical schemata, some *localized time-space notation* (thereby imparting a little temporal flexibility for **Cycles of Vega**’s instrumentalists):

Bold orthogonal brackets denote *localized time-space notation* that spans a duration corresponding to the rhythmic value directly above the left orthogonal bracket, at the prevailing tempo. Within this temporal grid, play any musical events between such brackets *approximately* in direct chronometric proportion to their relative horizontal placement upon the score-page. (Sustained durations herein are notated with extended beams, the end of a beam indicating the termination of a note.)²

While on the subject of rhythmic irregularity, I shall conclude by mentioning that quite a few of the e♭-clarinet part’s ‘irrational tuplets’ were instinctively composed as rebounds off,

or triggers to, certain of the percussion parts' *chronos-protos*-based durations. (For although the e♭ clarinet's music in **Cycles of Vega** is very rarely systemic, it nevertheless articulates its own distinguishable rhythmic 'language'.)

ENDNOTES

1. Such minutiae have been overlooked within the relevant tabulations from section 1.2.2.
2. **Cycles of Vega**, Performance Notes, p.iii.

Ian Shanahan (1988–1991)

– *To Eric Gross and Peter Sculthorpe*

For Roslyn Dunlop, Daryl Pratt and Tony Cowdroy to play:

~~~~~

# *Cycles of Vega*

for

sopranino clarinet in e $\flat$

and

percussion (2 players)

~~~~~

PROGRAMME ANNOTATION

Cycles of Vega

for $e\flat$ clarinet and percussion

Ian Shanahan (1988–1991)

In what may well become an ever-expanding set of compositions for wind and percussion instruments, **Cycles of Vega** is intended to be a 'companion piece' to an earlier work of mine: **Echoes/Fantasies** (1984), for bass clarinet, vibraphone(s) and tubular bells. Both of these compositions make use of various complex long-range cyclic transformations – hence the present work's name – as well as embracing related musical materials and structures.

The title "Cycles of Vega" makes oblique reference to my longstanding astronomical interests. Vega (α Lyrae), the brightest object in the 'musical constellation' Lyra, will become the Earth's north celestial pole-star sometime around 14,000 AD – since Earth's polar axis inexorably describes, or cycles through, a vast circle in the sky every 25,800 years or so. Considered to be the greatest astronomer of antiquity and the founder of systematic observational astronomy, Hipparchos of Nicaea (fl. 146–127 BC) was allegedly the discoverer of this diurnal cosmic process (referred to as 'precession') – although an explanation of precessional behaviour was not forthcoming for at least another 1,800 years, with the advent and codification of Newtonian mechanics! (Rotating bodies then perhaps began to be understood, a little...) At any rate, the (epi)cyclicity discernible within **Cycles of Vega** is certainly a 'precessional metaphor'. Intended to proclaim our Universe's grandeur, I trust that **Cycles of Vega** is not just some lifeless 'acoustical orrery', but is, rather, a truly vibrant model of the Cosmos it extols.

Much to my delight, I have learnt that the star Vega possesses a rich cultural history; its name is resonantly polysemic. According to Richard Hinckley Allen:*

The association of Lyra's stars with a bird perhaps originated from a conception of the figure current for millenniums in ancient India – that of an Eagle ... But the Arabs' title, *Al Nasr al Waki* – Chilmead's *Alvaka* – referring to the swooping Stone Eagle of the Desert, generally has been attributed to the configuration of the group α , ϵ , ζ [Lyrae], which shows the bird with half-closed wings ... Sayce identifies Vega, in Babylonian astronomy, with *Dilgan*, the Messenger of Light ... Owing to precession, it will be the Polaris of about 11,500 years hence, by far the brightest in the whole circle of successive pole-stars, and then 4.5' from the exact point, as it was about 14,300 years ago ... [Vega] was the first star submitted to the camera, by the daguerreotype process, at the Harvard Observatory on the 17th of July, 1850.

Moreover, the theologian E. W. Bullinger claims that the star-name Vega "means *He shall be exalted*".† And I also recall that in the science-fiction novel **Contact**,‡ written by the celebrated cosmologist Carl Sagan, modern radio astronomers first detect intelligent extraterrestrial life through the reception of a sequence of prime numbers transmitted from Vega!

Anyway, I try to evoke, within the sound-world of **Cycles of Vega**, an extremely unearthly, timeless, cosmic, astral state. In large part, this is achieved through the use of a rather unusual (even idiosyncratic) instrumentation – which includes twenty(!) varieties of windchime, seven *rin* (Japanese temple bells) and tubular aluminium sound-sources that I have constructed and assembled myself ("Shan Tubes"), as well as a number of other metallic percussion instruments. (Some of these instruments' microtonal tunings, and the $e\flat$ clarinet's technical treatment in general, additionally indicate an attempt on my part 'to look ahead' musically and aesthetically, liberated from the artificial restrictions of the past.)

The fascinating stochastic behaviours at play within the windchimes themselves – a prominent element of the piece, simply because these instruments are so numerous – provide a metaphorical mirror for the complex tumultuousness of the Cosmos itself: Cosmological Entropy, Chaos, and the Second Law of Thermodynamics ... as well as the seemingly random chaotic perturbations – 'nutation' – of the Earth's polar axis, which wobbles periodically in conjunction with the precession-of-the-equinoxes phenomenon, itself evinced by equinoctial points retrogressing ever so slowly along the ecliptic. (Such labyrinthine concepts, exhibiting 'disorder within meta-order', are encapsulated beautifully by James Joyce's neologism "chaosmos"!)

Furthermore, the intricate structural hierarchies woven into **Cycles of Vega** could perhaps be interpreted as an (admittedly gross) simplification, essence, sign, or symbol of the infinite architectonic nature of God's Universe.

Cycles of Vega was commissioned by the Australian clarinetist Roslyn Dunlop, with funds provided by the Performing Arts Board of the Australia Council for the Arts; it is gratefully dedicated to Ros – and also to two of my former composition teachers, Eric Gross and Peter Sculthorpe, at the University of Sydney.

© Ian Shanahan, Sydney, Australia; 10 March 1990.

* Richard Hinckley Allen: **Star Names: Their Lore and Meaning** (Dover Publications, Inc., New York, 1963; ISBN 0-486-21079-0), pp.282–286.

† Ethelbert William Bullinger: **The Witness of the Stars** (Kregel Publications, Grand Rapids, Michigan, U.S.A., 1995; ISBN 0-8254-2245-0), p.66.

‡ Carl Sagan: **Contact: A Novel** (Arrow Books Ltd., London, 1986); ISBN 0-09-950780-3.

Cycles of Vega was premièred by Roslyn Dunlop ($e\flat$ clarinet), Daryl Pratt (percussion), and Anthony Cowdroy (percussion), during the Second Sydney Spring International Festival of New Music, held at the Art Gallery of New South Wales, Art Gallery Road, The Domain, Sydney, on 2 November 1991. The composer was subsequently awarded **The Adolf Spivakovsky Memorial Prize for Composition** (1991), for **Cycles of Vega**.

A recording of **Cycles of Vega**, played by the same personnel, is now commercially available on the Compact Disc "Shoalhaven Suite" (Broad Music Records Jade JAD CD 1087).

HIPPARCHOS

Cycles of Vega,
stately precession:
Axial changes so slow.

Azimuth rising,
Pole Star declining:
spinning-top Earth 'round you go!

I. L. Shanahan, 31.8.1989.

PERFORMANCE NOTES

PREAMBLE

I wish to thank *Roslyn Dunlop* for her research assistance, for her kindness in demystifying the subtleties of the *e♭* (sopranino) clarinet for me, as well as her patient editorial guidance later on in the compositional process – particularly in relation to the deployment of many unusual *e♭* clarinet fingerings throughout **Cycles of Vega**. I am also greatly indebted to *Daryl Pratt* who, as usual, was keen to share his immense knowledge of the percussion genre and how to compose intelligently with it: for example, in deciding upon the layout and distribution of the percussion instruments in **Cycles of Vega** (thereby ensuring that mallets and percussion instruments would always remain compatible), Daryl's expert advice was invaluable. I thank him for his affable generosity.

1. GENERAL REMARKS

INSTRUMENTATIONAL REQUIREMENTS

• *Sopranino Clarinet in e♭*

• *Percussion (2 players)*

Percussion 1

- vibraslap {at rest on the mallet-tray}
- large autocoil {suspended high}
- very large triangle {suspended high}
- crotales (one octave set) {rack-mounted}
- vibraphone (*optional*: employ an assistant to regulate its rate of vibrato)
- 4 cowbells {rack-mounted}
 - 2 agógo bells
 - 2 cencerros
- 6 large-diameter “Shan Tubes” {suspended very high} *
- 3 suspended cymbals {all suspended on cymbal stands, but ideally grouped together in vertical order upon a single cymbal stand} †
 - 1 large sizzle cymbal
 - 1 large Chinese cymbal
 - 1 very large (Turkish) suspended cymbal

Percussion 2

- 3 suspended cymbals {all suspended on cymbal stands, but ideally grouped together in vertical order upon a single cymbal stand} †
 - 1 large sizzle cymbal
 - 1 large Chinese cymbal
 - 1 very large (Turkish) suspended cymbal
- dove call in C {hanging from a string, around the percussionist's neck!}
- vibraslap {at rest on the table with the rin}
- 8 windchimes, activated mainly by the percussionist's right hand {all suspended high}
 - 1 aluminium-tube windchime
 - 1 ceramic-disc windchime
 - 1 brass-bell windchime
 - 1 shell-disc windchime
 - 1 wooden-rod windchime
 - 1 bamboo-tube windchime

~ i ~

- 1 sea-urchin-spine windchime
- 1 herd-bell windchime
- ‘triangle windchime’ (3 triangles) {suspended high}
- 6 small-diameter “Shan Tubes” {suspended very high} *
- 7 Japanese temple bells (rin) {resting upon their traditional cushions, on a (cloth-covered) table}
- sleighbells {suspended high}
- 9 windchimes, activated mainly by the percussionist's left hand {all suspended high}
 - 1 wooden-rod windchime
 - 1 bamboo-tube windchime
 - 1 sea-urchin-spine windchime
 - 1 shell-disc windchime
 - 1 ‘Kenyan bell tree’
 - 1 ceramic-disc windchime
 - 1 brass-tube windchime
 - 1 aluminium-tube windchime
 - 1 brass-disc windchime
- very large tam-tam {suspended in a frame}

Note: technical specifications with detailed descriptions of all of these percussion instruments shall be given later; I have also appended to these Performance Notes a comprehensive diagram depicting their *physical layout*.

* Both sets of “Shan Tubes” require *very high* stands – reaching at least 2 metres above the floor! The “Shan Tubes” themselves are suspended in much the same manner as a set of commercially manufactured tubular bells, from many small hooks screwed into a pair of flat home-made rectangular wooden racks. However, in performance, these suspension-racks *must* be placed close enough together so that each set of “Shan Tubes” physically interacts with the other set, as a kind of single ‘super windchime’, at the climax of **Cycles of Vega** (bar 177).

† Note that until bar 39 in **Cycles of Vega**, both percussionists are able to share the same set of three (suspended) cymbals: duplicate instruments are therefore not needed (although their presence would serve to expand this composition's timbral spectrum).

ADJUSTMENT OF TEMPI, AND DURATION

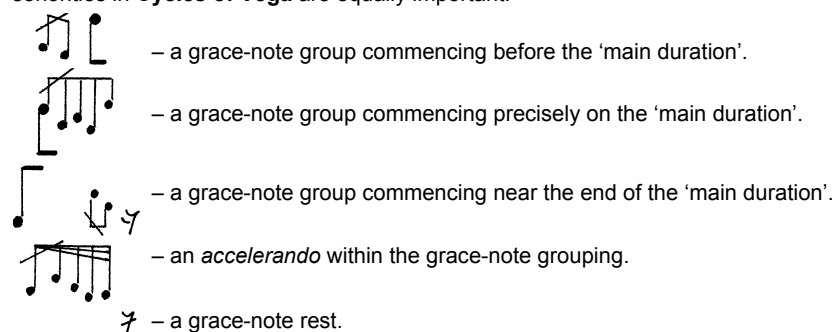
If the fastest tempi specified in **Cycles of Vega** prove to be overwhelming for the performers, then decrease *all* tempi *proportionately*, by the same factor – lest the work's architecture be distorted. (Likewise, the duration of each pause lasting a given number of seconds will need to be multiplied accordingly.) This is by no means a desirable circumstance, for the designated tempi are optimal and preferred: I therefore encourage all executants to work up to playing **Cycles of Vega** at these tempi!

Cycles of Vega embraces extremely subtle, long-range *accelerandi* and *decelerandi* (bars 12–36; bars 86–178; and bars 180–214), the contours of which are defined by approximate tempo-indications every bar or so. In order that performers attain the required shapes of these tempo-contours fairly accurately, they are advised to repeatedly ‘count through’ the piece with an *electronic metronome*, turning the device's dial correspondingly. This practice activity will greatly assist projecting, in concert, the right ‘feel’ of tempo-evolution. Of course, a certain degree of flexibility is permissible, provided that the general contours of tempi are preserved overall. Additionally, approximate durations (in minutes and seconds) of subsections of **Cycles of Vega** have been supplied, both singly and cumulatively, as an aid to executants in this respect.

~ ii ~

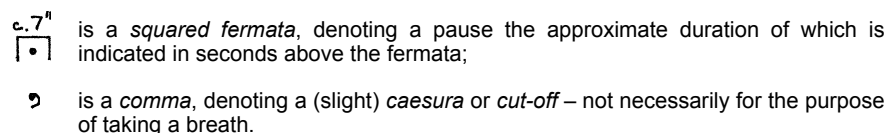
GRACE-NOTE GROUPS

Grace-notes occupy (very) short indeterminate durations, which are left to the discretion of the player. In general, they should be played quite rapidly (but not necessarily evenly), at a speed somewhat dependent upon local context and other instructions or technical exigencies. Grace-notes marked “agile” or “rapid” (etc.) should be interpreted accordingly, or even played ‘as fast as possible’ (“a.f.a.p.”). Furthermore, grace-notes ought not to be thought of as mere ‘ornaments’, of secondary architectonic status, to the ‘main notes’: *all* sonorities in **Cycles of Vega** are equally important!



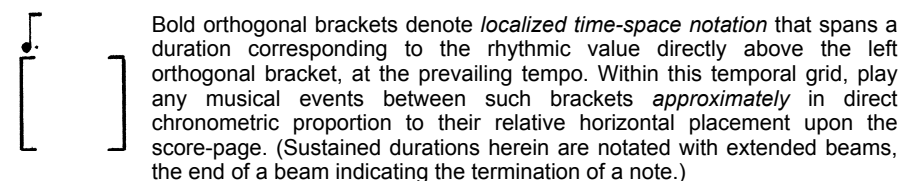
PAUSES

Unless otherwise indicated, precise durational details of pauses are left to the interpretation of the performers. The following symbology is employed:



The durations of other pauses – given as a squared fermata alone (≡) – are determined entirely by instrumental characteristics or other acoustical properties: e.g. “Pause until the Tam-Tam resonance is ‘*pp*’”; etc. (The appropriate textual instruction is always provided in conjunction with the squared fermata.) Sustained (approximate) durations within the ambit of such pauses are notated time-spatially – i.e. extended *beams* depict such local durations; the end of a beam indicates the termination of a (previously sustained) note.

LOCALIZED TIME-SPACE NOTATION



DYNAMIC INDICATIONS

Apart from the traditional dynamic indications (*ppp*, *pp*, *p*, *mp*, *mf*, *f*, *ff*, *fff*), the following symbols are employed in **Cycles of Vega**:

~ iii ~

p poss. and *f poss.* are abbreviations for ‘as soft as possible (but still audible)’ and ‘as loud as possible’, respectively;

<> >< small ‘*hairpins*’ (*crescendi* and *diminuendi*, without any other dynamic indications) signify a very subtle nuance of dynamic variation around the prevailing dynamic level;

○ represents the initial emergence from, or final vanishing into, *inaudibility*;

Dynamic indications apply until they are modified by the next dynamic instruction. Moreover, a proper balance of dynamics between instruments ought to be maintained throughout **Cycles of Vega**: for example, the perceived loudness of an *mf* sonority in one part should match that within the other two parts.

ARTICULATIONS AND ACCENTS

All articulations – *legato*, *tenuto*, *mezzo-staccato*, *staccato*, *staccatissimo*, *accent* (>), *sforzando* (^) etc. – should be duly observed. For the purposes of **Cycles of Vega**, a *tenuto* marking (–) is simply to be understood as a direction to sustain a sonority for its *full duration* as given (or even a little longer), and *staccatissimo* denotes a very short, clipped envelope (i.e. ‘*molto staccato*’): neither *tenuto* nor *staccatissimo* in themselves imply the application of *any* additional accent or stress whatsoever in the attack, unless otherwise indicated. Moreover, a *sforzando* attack will always be based upon the prevailing dynamic level, so that (for example) *sffz* = *sforzando* in *ff*.

QUARTERTONES, OTHER MICROTONES, AND PITCH DESIGNATION

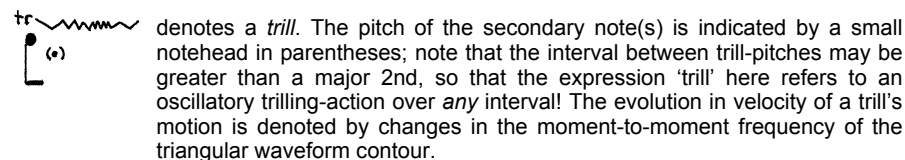
The following symbology for *microtones* is employed in **Cycles of Vega**:

♯ and ♭ denote a *quartertone above* ♮, and a *quartertone below* ♮, respectively (i.e. 24-tone equal temperament). Arrowheads upon any accidentals denote slight intonational deviations – up to about an eighthtone, but not necessarily tempered – in the given direction.

In any *textual references* to pitch herein:

- “Middle C” shall be designated as C_{♮3}, the C_♮ one octave higher as C_{♮4}, etc. (i.e. assuming that A_{♮3} = 440 Hz, then C_{♮3} ≈ 261.6255653 Hz).
- ♯ and ♭ denote a *quartertone above* ♮, and a *quartertone below* ♮, respectively. Smaller degrees of intonational deviation – slight microtonal inflections, non-tempered, of up to about an eighthtone – upwards and downwards are indicated by upward-pointing and downward-pointing arrowheads, respectively, upon accidental symbols. Examples: B_{♯5}; F_{♯4}; A_{♭3}; G_{♭2} etc.

TRILLS



In relation to trill-speed, “a.f.a.p.” is simply an abbreviation for ‘as fast as possible’.

~ iv ~

RANDOMIZED PARAMETERS

“Rand.” denotes the random treatment, over a specified duration, of individual, clearly indicated technical/musical parameters. Such parameters operate independently of one another when more than one parameter is so engaged. “Rand.” may be applied to the trilling-action of a (sub)set of fingers in a clarinet fingering, to the frequency modulation (i.e. speed-changes) in a trill or clarinet key-vibrato, or to the vibraphone’s vibrato-rate between given upper and lower limits, for instance.

CUEING ONE ANOTHER WITHIN BAR 39

Within each part comprising the *single, fluidly shaped macro-event* that spans bar 39 in **Cycles of Vega**, instructions are provided for *cueing or reacting to one another* – either as an instantaneous response to one musical gesture, or as a trigger for another executant to immediately perform some other musical gesture. Such ‘aural catalysts’ are notated as *large bold arrows*, together with the name of another instrument (and, if necessary, a technical description of what is being played upon that instrument) written nearby.

Elsewhere throughout **Cycles of Vega**, all interpreters are encouraged to discover, thence to notate within their own parts, additional points in the music when cueing one another *for the sake of accurate coordination* might prove salutary.

VISUAL IMPACT AND LIGHTING IN CONCERT

The gestural/theatrical aspect inherent within the instrumental set-up and public presentation of **Cycles of Vega** must *enhance* the music, not impede or contradict it. All physical gestures and actions must be seen to be deliberate, fluid, and totally controlled: this sort of ‘effortless theatricality’ is crucial, for instance, in the second percussionist’s performance upon their numerous windchimes (bars 1–179) – lest they appear instead to be merely a child running amok in its play-pen! Furthermore, the percussionists should pick up any mallets (or hand-held instruments, such as the vibraslap) as discreetly and unobtrusively as possible.

In mounting a performance of **Cycles of Vega**, I do encourage the artistic use of stage lighting and spotlights (of various hues), so long as they are employed *tastefully*. Such visual effects must enhance the cosmic, other-worldly soundscape of this piece!

2. THE SOPRANINO CLARINET IN E♭: DETAILS

E♭ CLARINET FINGERINGS

Every fingering-indication provided within the score of **Cycles of Vega** that *supplies the notated pitch(es) accurately over the given duration* is to be strictly adhered to: any modifications of such fingerings are forbidden! But whenever a fingering yields an unacceptably inaccurate outcome, or is acoustically untenable on a particular instrument, then the clarinetist is at liberty to alter that fingering – subject to the proviso that the resultant sonority matches, as closely as possible *in context*, the composer’s original intention. (If no such fingering exists, then just do your best with the provided fingering.) So, whatever fingerings end up being employed herein, the sonic results must always correspond as closely as possible to the notated pitches while retaining, as much as possible, the original timbral signatures generated by the specified fingerings.

Non-standard fingerings for *chromatic pitches*, for *tempered quartertones and other microtones*, and for *multiphonics* found in **Cycles of Vega** are appended within a prefatory

~ v ~

table – to aid the clarinetist in checking their intonational accuracy, to assist in the familiarization process, and for general practice purposes.

MULTIPHONICS

The notation of e♭ clarinet multiphonics in **Cycles of Vega** is necessarily incomplete: sidebands, such as ‘difference tones’, have been excluded. Nonetheless, the pitches of the highest and lowest component tones (the primary audible pitches) are carefully notated, and should therefore be fairly accurate in performance; this can be ascertained by playing through the abovementioned table. If, however, any *infinitesimal* pitch-discrepancies do occur in playing these multiphonics on your instrument, then they can be ignored!

The *steadiness* of (unstable) e♭ clarinet multiphonics is not a high priority: unless otherwise indicated, a reasonable degree of ‘inner fluctuation’ is acceptable. Similarly, it is my intention that certain *slow-speaking* multiphonics might be heard only incipiently, whenever their specified durations are insufficient to fully secure and stabilize all of their constituent pitches simultaneously.

VIBRATO

If used at all when not specifically called for, vibrato on the e♭ clarinet should be employed with considerable discretion throughout **Cycles of Vega**. Air-column vibrato (generated by pulmonic action), or perhaps even jaw-vibrato, is recommended; unspecified key-vibrato is, however, forbidden!

The following vibrato-types are called for at specific points in the music:

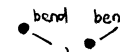


denotes a *key-vibrato*. Its fingering and trilling-action is specified by the tablature pictograph above the staff. The triangular waveform contour suggests micro-details of the key-vibrato’s frequency, which may be static or evolving. The emphasis here is upon *timbral* oscillation – although some small microtonal fluctuations may be evident as well. All e♭ clarinet key-vibrati employed in **Cycles of Vega** have been appended within a prefatory table, the rationale for selecting each key-vibrato’s fingering being that it achieves maximal timbral alteration with a minimal pitch-shift, wherever possible.



denotes a *jaw-vibrato*. Repeatedly inflect the given note’s pitch with the embouchure and/or through oral-cavity manipulations. The sinusoidal waveform contour suggests micro-details of the jaw-vibrato’s frequency and amplitude (i.e. the extent of pitch-alteration around the given note), either of which may be static or evolving. Precise details concerning the (maximum) width of pitch-inflection are left to the discretion of the clarinetist.

PITCH-BENDS AND PITCH-INFLECTIONS



denote downward and upward *pitch-bends*, respectively – they are executed with the embouchure and/or through oral-cavity manipulations. (Ameliorative changes of fingering-configuration during a pitch-bend are permissible, so long as the pitch-bend itself sounds perfectly smooth.) Pitch-bends should always be carried out towards the end of the indicated duration; moreover, the termination of the ‘bent’ tone must never be emphasized. Soft (diminuendo) downward pitch-bends are to be reminiscent of a sigh, as if the clarinetist is running out of breath! Precise details concerning the range of

~ vi ~

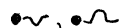
the pitch-bend are left to the discretion of the clarinetist.



In exactly the same manner as above (including permissible changes of fingering-configuration), bend the tone upwards as far as possible, smoothly.

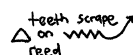


denotes a 'fall-off' – a pitch-bend falling downwards as far as possible or practicable, using finger-action as well as embouchure and/or oral-cavity manipulations. Allow the tone to break down and smear into lower registers as well!



denote downward and upward *pitch-inflections*, respectively. These are equivalent to their pitch-bend counterparts – except that the pitch promptly returns to the initial given pitch, as shown. The timing of the pitch-inflection within the note's overall duration is clearly indicated on each occasion.

TEETH-ON-REED



By placing your lower teeth directly upon the e♭ clarinet's reed, project a thin, piercing, rather unstable but extremely high-pitched (indeterminate) sound; include changes in embouchure-pressure as well. Then scrape your lower teeth up and down over the reed's surface, to create a rough 'broken portamento' effect, including random changes of partial. End the event on as high a pitch as possible, as shown. (Note that such sound-production activities evolve independently of fingering considerations.)

ARTICULATION

The following special articulations for the e♭ clarinet are utilized in **Cycles of Vega**:



denotes *fluttertonguing*, a trilling of the tongue-tip against the alveolar ridge, or alternatively, a trilling of the back of the tongue against the uvula (soft palate) – as in gargling. Either type of fluttertonguing is acceptable within **Cycles of Vega**: the type, intensity, and speed of the fluttertonguing to be employed at each occurrence are left to the discretion of the clarinetist.



denotes a *slaptongue*. Place a large portion of your tongue against the reed, thereby creating a vacuum between the surface of your tongue and the reed. Suddenly 'break' this vacuum by pulling your tongue down away from the reed – this is often accompanied by a drop in jaw-pressure – whilst simultaneously initiating the air-stream. Such actions on an e♭ clarinet should result in a very strong, almost percussive attack to a normally-blown note: this instrument's reed is simply too small to generate the characteristic 'thud' of a larger reed noisily rebounding against the mouthpiece, as in a bass clarinet slaptongue. The clarinetist should vary the slaptongue's intensity in accordance with the indicated dynamic level.



denotes an *aspirated attack*, with minimal intensity, using the phoneme 'h' (as in "hamster"): the sonority is to be rendered *without any 'tonguing' whatsoever!*



denotes a *diaphragm thrust*. Attack the note with a sharp jolt or impulse from the diaphragm only; do *not* 'tongue'. Again, the articulatory action here is entirely aspirated and pulmonary – but with the aspiration being suitably intensified and heavily accentuated.



denotes a rising *pitch-bend (portamento) attack*, executed at the beginning of, or immediately prior to, the indicated duration: the technique needed here is precisely the same as that required to produce a pitch-bend (see above). The pitch-range covered by this smooth, upward 'scoop' into the note is left to the discretion of the clarinetist.



denotes a (very) brief '*squawk*' *attack* – involving any (very) high pitch elicited from, or somehow related to, the fingering for the primary note, overblown. This colourful attack can be achieved by momentarily touching your lower teeth against the reed; or perhaps better still, curl your lower lip back behind the reed and behind your upper teeth, and with sufficiently high breath-pressure, then allow your lower lip to be blown forward, bursting explosively into its normal embouchure position, thereby yielding a particularly dramatic, raucous overblown attack. The sound, as I have imagined it while composing **Cycles of Vega**, is merely an inseparable part of the note's attack characteristic, and so ought to resemble the occasional transient squeak/squawk noises of a tenor or baritone saxophone that occur sometimes at a change of register in playing jazz.

AIR-SOUNDS



denotes an *air-sound*, in which the given (first-register) pitch is fingered while air is blown through the e♭ clarinet with a loose embouchure that is insufficient to cause the generation of a normally-produced tone: a breathy tube-resonance with a clearly discernible pitch-centre (corresponding to the fingering's fundamental mode of vibration) ensues. Note that an air-sound's timbral quality may be modified in a quite subtle but continuous manner through fluctuations in breath-pressure, or by varying the embouchure and the shape of the oral cavity: the sensible application of these techniques is left entirely to the discretion of the clarinetist. Whenever the circular notehead is drawn non-specifically beneath the staff (bars 1–35), the air-sound's pitch-bias is indeterminate.



denotes a normally-produced tone that contains *strong air-coloration* (i.e. 'breathiness').



denotes a *transition* from a 'pure' tone (containing no air-coloration) to an air-sound.



denotes a *transition* from an air-sound to a 'pure' tone (containing no air-coloration).

KEY/FINGER-SOUNDS



denotes a *key/finger-sound*, in which the e♭ clarinet's key-mechanism is made audible and/or tube-resonances are generated by keys/fingers slapping shut *hard* over their holes, in addition to the blown tone. In trilling actions, an x is drawn above the triangular waveform contour; the finger(s) engaged in the ongoing percussive activity are usually identified with an x in the tablature pictograph. A *transition* to prominent key/finger-sound (*f poss.*) is indicated by ----- x.

3. THE PERCUSSION INSTRUMENTS: DETAILS

PREAMBLE

Cycles of Vega calls for a number of highly exotic and/or extremely rare – even unique

– percussion instruments. Therefore, in order not to make this piece's realization prohibitively difficult, I propose the following practical solutions:

- Many of these percussion instruments can be obtained directly from the composer.
- Alternatively, percussion instruments such as the windchimes and the “Shan Tubes” can easily be constructed according to the detailed specifications provided herein.
- Some substitutions are permissible; specific suggestions will be made later in this regard.
- Electroacoustic sound-production (e.g. digital sampling and the activation of samples with MIDI percussion instruments – or even digital synthesis and signal processing with a synthesizer or computer, rather than sampling) is another viable possibility, if certain percussion instruments are definitely unavailable; this is by no means an ‘ideal solution’ (either acoustically or visually), though.

It is crucial that the microtonal tunings of many of the percussion instruments described below be preserved *at all costs*: these particular micro-intonations were very much fixed in my ‘mind’s ear’ throughout the composition of **Cycles of Vega**; it is, therefore, obligatory that instruments which conform as closely as possible to these tunings be procured! Note that certain percussion instruments whose pitches *almost* match those designated may in fact be inflected accordingly: for example, some rin pitches could be flattened somewhat by pouring a certain amount of water into the rin (although the water’s inertia does entail an undesirable loss of rin resonance); cowbell pitches may be flattened similarly by adhering some extra weight (e.g. large lead fishing sinkers embedded within a malleable gummy substance such as “Plasticine” or “Blutac”) inside the cowbells, etc.

RESONANCE AND ARTICULATION

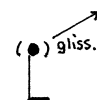
- ~ denotes Allow the note(s) to *resonate beyond their specified duration*. Unless otherwise directed, such notes should be allowed to resonate until their sound has completely dissipated. The complex aleatoric sound-textures of all *windchimes* (and cognate instruments) must always be permitted to decay into silence!
- ◇ denotes *damping* the resonance of the specified instrument(s) – by hand, or with a mallet – *to silence* after it has been struck, at precisely the moment in time corresponding to the rhythmic placement of the closed-diamond notehead.
- * denotes a ‘*deadstick*’. Once the mallet has struck a sound-producer of an instrument, it remains in physical contact with the strike-point, without rebounding, thereby muffling or damping any after-resonance. In **Cycles of Vega**, this technique is applied only to the vibraphone (in “non Ped.”). The resultant vibraphone sound’s envelope will thus be a fairly brief ‘choked’ staccato.
- (*) A parenthesized × – (×) – upon a vibraphone note’s stem denotes ‘*deadsticking*’ if at all possible.
- ≡ denotes a *tremolo* using (at least) two mallets.

ARPEGGIATION

- ↗ – *arpeggiate* the notes in a somewhat leisurely manner.
- ↘ – (*very*) *rapidly* arpeggiate the notes of the chord.

For both forms of *arpeggiation*, their speed of execution is left to the discretion of the performer. *Arrowheads* upon the above symbols indicate the *direction* of the arpeggio’s action: ↑ = play the *lowest pitch* of the chord first; ↓ = play the *highest pitch* of the chord first.

GLISSANDI



denotes a *glissando*, in the given direction. The glissando’s initial (parenthesized) note should not be accentuated or individually attacked; the glissando’s ending-note – likewise played with absolutely *no* emphasis – is indeterminate, but corresponds vaguely to the point where the glissando’s line-contour terminates with an arrowhead: such glissandi usually cover as wide a range as possible. Whenever this arrowhead is replaced by a regular notehead in parentheses, the glissando’s ending is now, of course, clearly specified; however, exactly as with the glissando’s initial note, this final note must not at all be attacked individually.

The actions of all glissandi in **Cycles of Vega** always span the entire duration as notated.

Any accidental in front of a glissando’s initial pitch (i.e. ‘sharp’ [♯] or ‘flat’ [♭], or ‘natural’ [♮]) unambiguously indicates whether the glissando-action shall take place upon a keyboard percussion instrument’s ‘white’ (diatonic ‘natural’) or ‘black’ (pentatonic ‘accidental’) notes.

MALLETS

The following pictographs illustrate the different types of percussion mallet called for throughout **Cycles of Vega**. Drawn together in various combinations *within rectangular boxes*, such pictographs show the number, type, and deployment between the left and right hands of mallets required over each section of the music; no more than two mallets per hand are ever needed. Usage of the ‘plus’ and ‘minus’ symbols (+, −) in this context indicates a straightforward temporary change from the basic mallet-configuration. In relation to certain percussion instruments (such as the autocoil and the crotales), a mallet pictograph marked “sempre” means that henceforth, until further notice, only the indicated mallet-type is to be used to elicit sound from this instrument. Otherwise, a non-boxed mallet pictograph just refers to a specific percussion instrument and note.

Note: L.H. = the left hand; R.H. = the right hand.

PERCUSSION 1



denotes a very hard and heavy brass glockenspiel mallet.



denotes a yarn-wound vibraphone mallet of medium hardness.








denotes the **vibraslap**, held by the right hand (bars 4–36)! Strike the specified percussion instruments with the vibraslap’s hard wooden ball!



Play the vibraphone glissando with the very end of the vibraphone mallet’s rattan/cane handle (bar 39)!

PERCUSSION 2

-  denotes a very hard and heavy brass glockenspiel mallet.
-  denotes a large, (very) soft tam-tam beater. This tam-tam beater should be carefully suspended from the tam-tam's frame in such a way that the beater's interference with (damping of) the tam-tam's resonance, after the tam-tam has been struck, is non-existent or negligible.
-  denotes a very hard plastic (or heavy brass) glockenspiel mallet.
-  denotes a yarn-wound vibraphone mallet of medium hardness.
-  denotes an authentic hard wooden rin beater (*not* the soft, suede- or kidskin-bound variety); such beaters usually accompany the rin themselves. This quite rare type of beater resembles a short wooden rod, about 150 mm long, wrapped lightly with thin colourful cloth: if it is unavailable, then substitute an ordinary hard wooden or hard plastic mallet instead.

PERCUSSION INSTRUMENTS: DETAILED DESCRIPTIONS AND ABBREVIATIONS

Within the two percussion parts, all of the percussion instruments are notated in sequential order according to their physical distribution; they are listed below in the same fashion.

PERCUSSION 1

Vibraslap: Vbslp

Select a vibraslap with as wide a dynamic- and resonance-range as possible! A metal vibraslap (with a wooden ball) is quite acceptable.

Large Autocoil: Coil

A large helical spring, from the front-end suspension of a car, hung up high by a leather bootlace. An arrow to the left of a notehead indicates a sweeping rasp-like 'arpeggiando' attack (either upwards or downwards) that dramatically runs along the whole length of the helix, striking most (or all) loops in rapid succession; otherwise, for the coil's normal mode of performance, tap just a single loop.

Very Large Triangle: Tri

Use the largest triangle you can possibly find, suspended high! (Its timbre must be quite different to that of the large autocoil.)

Crotales: Crot

Written range: C \sharp 4 — C \sharp 5, sounding two octaves higher than notated. The thirteen crotali should be rack-mounted, in the manner of a keyboard. If preferred however, a set of thirteen rack-mounted crotali sounding one octave lower than those described above (i.e. with the written range C \sharp 4 — C \sharp 5, but sounding just one octave higher than notated) may be employed instead. This lower-octave set of crotales will certainly possess a greater resonance and longer decay-times than the higher-octave set; in any case, the actual sounding octave of crotales does tend to be somewhat ambiguous to the ear.

Vibraphone: Vib

Range: F \sharp 2 — F \sharp 5. A high-quality modern instrument (with wide bars in the low register) is required. The vibraphone must also be equipped with an electric motor and potentiometer that will yield a continuously variable speed of vibrato — widely ranging from 'slow' to 'fast'; an

instantaneous vibrato on/off capability, activated by a switch and/or by the potentiometer, is needed as well. Indeed, the vibraphone's vibrato must be able to be turned on or off with the potentiometer alone: for instance, this faculty is crucial for the initial vibrato accelerando, in bar 44.

Vibraphone Vibrato: Rates of vibrato on the vibraphone are specified by ringed numbers: ① indicates non-vibrato (i.e. 'motor off'); ⑥ signifies the vibraphone's maximum vibrato-frequency; ① and ② ≈ 'slow' vibrati; ③ and ④ ≈ 'medium' vibrati; and ⑤ ≈ a 'fast' vibrato. Between the extremes of ① and ⑥, the numbers ①, ②, ③, ④, and ⑤ denote approximately equal gradations of vibrato-rate; hence, each of these numbers is perhaps best thought of as a narrow bandwidth of vibrato-frequencies, so that ③ (for example) does not designate a precise, fixed rate of vibrato for each of its occurrences. When the vibraphone's motor is turned off (i.e. to ①: non-vibrato), do please remember also to rotate the vibrato-discs at the top of the instrument's resonators to their vertical position — in order to capture the vibraphone's maximum degree of sonorousness. Smooth transitions between numbered rates of vibrato (i.e. vibrato accelerandi or vibrato rallentandi) are depicted by appropriately sloping dashed lines which connect the ring around one vibrato number to that around the next. NB: It is most probably advantageous to employ an assistant whose sole purpose will be to manipulate the vibraphone's potentiometer, and thus regulate its rate of vibrato.

Vibraphone Pedalling: All pedalling on the vibraphone is clearly indicated throughout **Cycles of Vega**. "non Ped." must be strictly observed! (No damping of resonance by hand is called for anywhere in this work.)



Glissandi across the Vibraphone's Resonator Tubes: Using the ball of the vibraslap, execute an extremely violent glissando across most or all of the vibraphone's resonator tubes, sweeping from left to right, starting with the resonator tube for F \sharp 2 — a very aggressive, quite ugly rasping sound (bars 4–36)! Do allow the vibraslap to resonate fully as well, please.

4 Cowbells: Cowb

Two agogo bells (Cowb 1 & 2) and two cencerros (Cowb 3 & 4), rack-mounted. The agogo bells may be replaced by cencerros, herd bells, almglocken, metal blocks or other forms of cowbell, if desired. Do not muffle or mute the cowbells in any way! The cowbells' timbre should be rather clangorous, not too mellow — although their given pitches must be readily distinguishable. The four cowbells utilized for the world première performance of **Cycles of Vega** were pitched as follows: 1 — B \sharp 4; 2 — G \sharp 4; 3 — G \sharp 4; 4 — F \sharp 4.

6 Large-Diameter "Shan Tubes": ShTL

These home-made metallic percussion instruments — which resemble large-diameter tubular bells (but are instead able to sway quite freely, as a kind of windchime) — are mostly struck individually, with vibraphone mallets. They all project a slightly 'dirty' gong-like sound — akin to that of the Javanese gamelan kettle-gongs known as 'kethuk'. It is of no consequence that "Shan Tubes" struck with mallets may themselves strike other "Shan Tubes" — although, if possible, this sort of knock-on effect really should not occur during low dynamic levels. A stem with a ^ drawn upon it denotes striking a large-diameter "Shan Tube" near its point of suspension: aside from timbral considerations, such a strike-point minimizes the possibility of the tube clicking against other tubes. Note that some trills on the large-diameter "Shan Tubes" can be carried out with one hand, by rattling a mallet very rapidly between two adjacent tubes. At bar 177, use both hands to collide all of the large-diameter "Shan Tubes" together in an explosively violent manner; agitate them further according to the given graphics! After bar 179, the interacting "Shan Tubes" will continue to click together for at least one minute into section J! This is intentional and has been taken into account by the composer, so do not attempt to damp the resonant sound-texture of this 'super windchime'.

ShTL Specifications: six aluminium (zinc-plated?) tubes: 52 mm outer diameter, with a seam; 1.2 mm gauge. Lengths: 1 — 604 mm; 2 — 876 mm; 3 — 952 mm; 4 — 1062 mm; 5 — 1122 mm; 6 — 1372 mm. The six large-diameter "Shan Tubes" that were utilized for the world première performance of **Cycles of Vega** produced the following readily-perceived pitches (although other, more obscure resonances are present as well): 1 — A \sharp 4; 2 — A \sharp 3, [D \flat 5]; 3 — F \sharp 3, B \sharp 4; 4 — [D \sharp 3], G \sharp 4; 5 — [C \sharp 3], F \sharp 4; 6 — [F \sharp 2], B \sharp 3.

3 Suspended Cymbals: Cym:

1 Large Sizzle Cymbal: Sizz

A large, very resonant, thin sizzle cymbal, possessing a high 'sizzle' and a long decay.

1 Large Chinese Cymbal: Ch

A (very) large, resonant Chinese cymbal.

1 Very Large (Turkish) Suspended Cymbal: Susp

A very large, 'splashy' Turkish suspended cymbal, pitched somewhat below the Chinese cymbal.

PERCUSSION 2

3 Suspended Cymbals: Cym

Until bar 39 in *Cycles of Vega*, both percussionists are able to share the same set of three (suspended) cymbals, whose details are given immediately above: duplicate instruments are therefore not required (although their presence would serve to augment this piece's timbral palette).

Dove Call in C: Dove

A dove call pitched at C \sharp 4, with its second-register tone (overblown attack transient) pitched at G \sharp 5. This simple wind instrument – played just once (in bars 43–45) – is suspended from a string around the percussionist's neck, being gripped in the mouth between both lips and/or the teeth. A mellow, hollow, eerie 'hooty' woodwind sound is required: acoustically, the dove call is a stopped pipe, which therefore must be blocked at its lower end. If an 'authentic' dove call is definitely unavailable, then use, as a substitute, a slide whistle (i.e. 'Swanee whistle') with its slide fastened into position once C \sharp 4 has been found. In any event, the chosen sound-producer must correctly furnish C \sharp 4! The following symbology is employed:



Attack the note strongly with the articulation phoneme 'tah', so that it overblows briefly to G \sharp 5.



An air-column vibrato, generated by pulmonary (blowing) action. Shape the vibrato's speed and depth in accordance with the sinusoidal waveform contour.



Roughly in accordance with the dotted contour, blow harder so that the dove call's C \sharp 4 rises approximately a semitone (thereby generating 'beats' with the vibraphone's C \sharp 4), then allow it to fall to at least a major second below the original C \sharp 4 – completely dying away to inaudibility. The single gesture as a whole ought to be extremely expressive!

Vibraslap: Vbslp

Select a vibraslap with as wide a dynamic- and resonance-range as possible! A metal vibraslap (with a wooden ball) is quite acceptable. This vibraslap must possess a timbre quite distinct from the vibraslap played by the other percussionist.

8 Windchimes, activated mainly by the percussionist's right hand [R.H.]:

1 Aluminium-Tube Windchime: AW *

This metallic windchime consists of six aluminium tubes: 25 mm outer diameter; 2 mm gauge. Lengths: 1 – 348 mm; 2 – 370 mm; 3 – 399 mm; 4 – 430 mm; 5 – 468 mm; 6 – 500 mm. Its large central disc, made of hard plastic, strikes each tube towards its midpoint; very little displacement of this central disc should be needed to make all of the tubes resound. The aluminium-tube windchime that was utilized for the world première performance of *Cycles of Vega* produced the following readily perceived pitches, a 'quasi-pentatonic' set (although other, more obscure resonances are also present): 1 – D \sharp 5; 2 – C \sharp 5; 3 – A \sharp 4; 4 – G \sharp 4;

5 – E \sharp 4; 6 – D \sharp 4. This windchime possesses a mellow, starry, 'soft' sound – slightly rin-like in timbre (but different to ShTS 1 and ShTS 2 [see below]); ca.30" decay!

1 Ceramic-Disc Windchime: CW *

This earthenware windchime consists of six to ten large glazed ceramic discs, which may be irregularly shaped. It should possess a rich and resonant sound – 'loud', mellow, relatively low-pitched; ca.15-20" decay.

1 Brass-Bell Windchime: BrBW

This metallic windchime consists of three tiny brass/bronze bells (without clappers) suspended in a horizontal line from a rod – with the lowest-pitched bell hung in the middle, just touching the other two bells. These bells' approximate pitches are: 1 – C \sharp 8; 2 – C \sharp 7; 3 – G \sharp 6. Their timbre should be very cutting; ca.5" decay. Jolt, displace or shake the bells' suspending rod (or the bells themselves) to trigger a sequence of echoed attacks – roughly in accord with the notated waveform contours.

1 Shell-Disc Windchime: ShW *

This 'crustaceous' windchime consists of many large discs made of shell, suspended vertically in several lines. It should possess a 'hard' moderately loud clattery sound – medium- to high-pitched; ca.5" decay.

1 Wooden-Rod Windchime: WW *

This ligneous windchime consists of many cylindrical hardwood rods. It should possess a more brittle sound than the bamboo-tube windchime described immediately below – medium- to high-pitched; ca.5" decay.

1 Bamboo-Tube Windchime: BaW *

This vegetal windchime consists of many hollow, round bamboo rods/tubes. It should possess a very dry, hollow sound – medium- to high-pitched, but lower-pitched than the wooden-rod windchimes described immediately above; ca.5" decay.

1 Sea-Urchin-Spine Windchime: SUW *

This rather rare 'echidermous' windchime consists of numerous sea-urchin spines. It should possess an extremely high, dry, delicate sound; ca.10" decay. If a sea-urchin-spine windchime cannot be obtained, then it may be replaced by a stone or glass windchime.

1 Herd-Bell Windchime: HW *

This metallic windchime consists of four quite small cylindrical iron(?) herd bells, with clappers, suspended in a circle. These herd bells' pitches are: 1 – B \flat 4; 2 – B \flat 4; 3 – A \sharp 4; 4 – G \sharp 4. Such a homespun windchime can be readily constructed by appropriately suspending four (clapped) cowbells of any type or shape – so long as they render the abovementioned pitches; ca.2" decay.

'Triangle Windchime': Δ WC *

Three triangles of different size/pitch – i.e. small, medium, and large triangles – suspended high and grouped together (as a windchime) in such a way that each triangle bangs against the others without losing much of its natural resonance.

6 Small-Diameter "Shan Tubes": ShTS

These home-made metallic percussion instruments – which resemble small-diameter tubular bells (but are instead able to swing quite freely, as a kind of windchime) – are mostly struck individually, with hard wooden cloth-covered rin beaters. The four longest tubes manifest a timbre very much like tubular bells, whilst the shortest two tubes sound slightly rin-like. It is of no consequence that "Shan Tubes" struck with rin beaters may themselves strike other "Shan Tubes" – although, if possible, this sort of knock-on effect really should not occur during low dynamic levels. A stem with a ^ drawn upon it (bar 168) denotes striking a small-diameter "Shan Tube" near its point of suspension: aside from timbral considerations, such a strike-

point minimizes the possibility of the tube clicking against other tubes. At bar 177, use both hands to collide all of the small-diameter “Shan Tubes” together in an explosively violent manner; agitate them further according to the given graphics! After bar 179, the interacting “Shan Tubes” will continue to click together for at least one minute into section J! This is intentional and has been taken into account by the composer, so do not attempt to damp the resonant sound-texture of this ‘super windchime’.

ShTS Specifications: six anodized aluminium tubes: 22 mm outer diameter; 1.6 mm gauge. Lengths: 1 – 573 mm; 2 – 603 mm; 3 – 917 mm; 4 – 1041 mm; 5 – 1146 mm; 6 – 1221 mm. The six small-diameter “Shan Tubes” that were utilized for the world première performance of **Cycles of Vega** produced the following readily-perceived pitches (although other, more obscure resonances seem to be present as well): 1 – G \sharp 3, C \sharp 5; 2 – F \sharp 3, B \sharp 4; 3 – F \sharp 4; 4 – D \flat 4; 5 – A \flat 3; 6 – G \sharp 3.

7 Japanese Temple Bells (Rin): Rin

Seven small- to medium-sized Japanese ‘cup bells’, resting upon their traditional cushions, which radiate extremely beautiful, resonant, sparkling, microtonal bell-sounds – all of them exhibiting very long decay-times. (Their resonance-times are: 1 – 13" [ppp] to 31" [ff]; 2 – 12" [ppp] to 25" [ff]; 3 – 14" [ppp] to 28" [ff]; 4 – 15" [ppp] to 33" [ff]; 5 – 15" [ppp] to 35" [ff]; 6 – 15" [ppp] to 45" [ff]; 7 – 20" [ppp] to 55" [ff].) When the smaller rin are struck forcibly, there is a slight but possible danger that they may be overturned and tipped off their cushions. Such a calamity can be prevented simply by attaching “Velcro” (or some other adhesive device) to each rin’s base and cushion – thereby physically attaching each rin to its cushion. However, the rins’ resonances absolutely must not be interfered with! (It might also be advisable to fasten the rin-cushions themselves to the table with pieces of string or masking tape.) Note that some trills on the rin (e.g. bars 54–55) are to be executed with just one hand, by rattling a single rin beater rapidly between two adjacent rin. The seven rin utilized for the world première performance of **Cycles of Vega** were pitched as follows (although other, higher partials are clearly audible as well): 1 – B \flat 4; 2 – A \flat 4; 3 – G \flat 4; 4 – F \flat 4; 5 – D \flat 4; 6 – B \flat 3; 7 – G \flat 3.

Sleighbells: Sleigh

A lush-sounding ribbon/loop-type sleighbell consisting of many individual pellet-bell elements, suspended high and struck (almost never shaken). A ghungrü (Indian bell strap) may be substituted, if necessary.

9 Windchimes, activated mainly by the percussionist’s left hand [L.H.]:

1 Wooden-Rod Windchime: WW *

This ligneous windchime consists of many cylindrical hardwood rods. It should possess a more brittle sound than the bamboo-tube windchime described immediately below – high-pitched (higher than the R.H. WW); ca.5" decay.

1 Bamboo-Tube Windchime: BaW *

This vegetal windchime consists of many hollow, round bamboo rods/tubes. It should possess a very dry, hollow sound – medium- to high-pitched, lower-pitched than the wooden-rod windchimes described immediately above, but slightly higher-pitched than the R.H. BaW; ca.5" decay.

1 Sea-Urchin-Spine Windchime: SUW *

This rather rare ‘echidmous’ windchime consists of numerous sea-urchin spines. It should possess an extremely high, dry, delicate sound – even higher-pitched than the R.H. SUW; ca.10" decay. If a sea-urchin-spine windchime cannot be obtained, then it may be replaced by a glass or stone windchime.

1 Shell-Disc Windchime: ShW *

This ‘crustaceous’ windchime consists of many small discs made of shell, suspended vertically in a circle. It should possess a ‘soft’, gentle, delicate, brittle but dense sound – medium- to high-pitched; ca.5" decay.

1 ‘Kenyan Bell Tree’: KBT

This unusual metallic windchime consists of about twenty or so bronze conical and cylindrical bells (with clappers), suspended in a flat diamond-shaped frame, microtonally pitched within the range C \sharp 5 – C \sharp 7. The Kenyan bell tree’s timbre should be a high-pitched, delicate, fairly dry jingle, rather cutting; ca.5" decay. Jolt, displace or shake the framework to activate the bells, in accord with the notated waveform contours. If necessary, the Kenyan bell tree may be replaced by many very high, bundled-together almglocken, or – better still – a ‘string of jingle bells’ (strung together as a windchime).

1 Ceramic-Disc Windchime: CW *

This earthenware windchime consists of six to ten small circular glazed ceramic discs. It should possess a rather cutting sound – relatively high-pitched; ca.10" decay.

1 Brass-Tube Windchime: BrTW *

This metallic windchime consists of ten or so small thick brass tubes (outer diameter ca.6 mm, maximum length ca.120 mm), sounding within the range C \sharp 6 – C \sharp 7: brilliant, starry, cutting, high-pitched; ca.10-15" decay. If necessary, randomly-chosen rods from a Mark Tree may be hung in a circle as a substitute for this windchime.

1 Aluminium-Tube Windchime: AW *

This metallic windchime consists of six aluminium alloy (Duralumin?) tubes: 32 mm outer diameter; ca.1.8 mm gauge. Lengths: 1 – 210 mm; 2 – 220 mm; 3 – 310 mm; 4 – 330 mm; 5 – 402 mm; 6 – 503 mm. The aluminium-tube windchime that was utilized for the world première performance of **Cycles of Vega** produced the following readily perceived pitches (although other, rather more obscure resonances are also present): 1 – B \flat 6; 2 – A \flat 6; 3 – B \flat 5; 4 – G \sharp 5; 5 – D \flat 5; 6 – F \sharp 4, [B \flat 5]. This windchime possesses a brilliant, starry, ‘hard’ sound – slightly crotales-like in timbre, quite loud; ca.15" decay.

1 Brass-Disc Windchime: BrDW *

This metallic windchime consists of several thin brass discs, not necessarily regular in shape. Their timbre should be clangorous – a high-pitched, extremely resonant and rich sound; ca.5" decay.

Very Large Tam-Tam: T-T

A very large, resonant tam-tam (at least 1300 mm in diameter, if possible) – very deep, profound and mysterious! Apart from the following cases, strike the tam-tam in its usual, slightly off-centre beating-spot.



Strike the tam-tam at its central point, and strike the tam-tam away from its central point (towards its rim), respectively.

* Windchimes [Percussion 2 only]

Agitate the elements of these windchimes directly, with hand(s) or mallet(s), roughly in accord with the notated waveform contours. All windchime attacks and excitations should be varied as much as possible, subject to the indicated dynamic level.

As a rehearsal- and performance-aid, for easier readability of the numerous windchimes’ notes (i.e. correctly matching these notes to their corresponding windchimes), the noteheads written upon the windchimes’ staves could be colour-coded using a wide variety of highlighter pens or coloured pencils. The percussionist might even consider carefully attaching the associated colour of ribbon or a strip of coloured paper to each windchime somehow; these ribbons or paper-strips must not cause any impedance whatsoever to the windchimes’ typically stochastic acoustical behaviour. (Besides being musically functional props, such visual variegations will help to impart a beneficial ambience of decorativeness and festivity!)

SINGLE PITCHES AND TRILLS

E-FLAT CLARINET FINGERINGS

Handwritten musical notation and fingering diagrams for E-flat Clarinet, categorized by section.

Top Section: Single Pitches and Trills

- Notes: N, N, N, (E), C#, A^b, A^b, A^b, A, RA, RA, N, N, N, R, R, R, R, R, R, N, R.
- Diagram: Fingering diagrams for each note, showing finger positions on the keys.

Left Hand Alone...

Handwritten musical notation for the left hand alone, showing notes and fingerings.

Right Hand Alone...

Handwritten musical notation for the right hand alone, showing notes and fingerings.

General (non-standard) fingerings - both hands...

Handwritten musical notation for general (non-standard) fingerings for both hands.

KEY VIBRATI

Handwritten musical notation and fingering diagrams for key vibrati, showing notes and fingerings.

Left Hand Alone...

Handwritten musical notation for the left hand alone, showing notes and fingerings.

Right Hand Alone

Handwritten musical notation for the right hand alone, showing notes and fingerings.

Both Hands...

Handwritten musical notation for both hands, showing notes and fingerings.

Left Hand Alone...

Handwritten musical notation for the left hand alone, showing notes and fingerings.

Right Hand Alone (see bar 129)

Handwritten musical notation for the right hand alone, showing notes and fingerings.

Both Hands...

Handwritten musical notation for both hands, showing notes and fingerings.

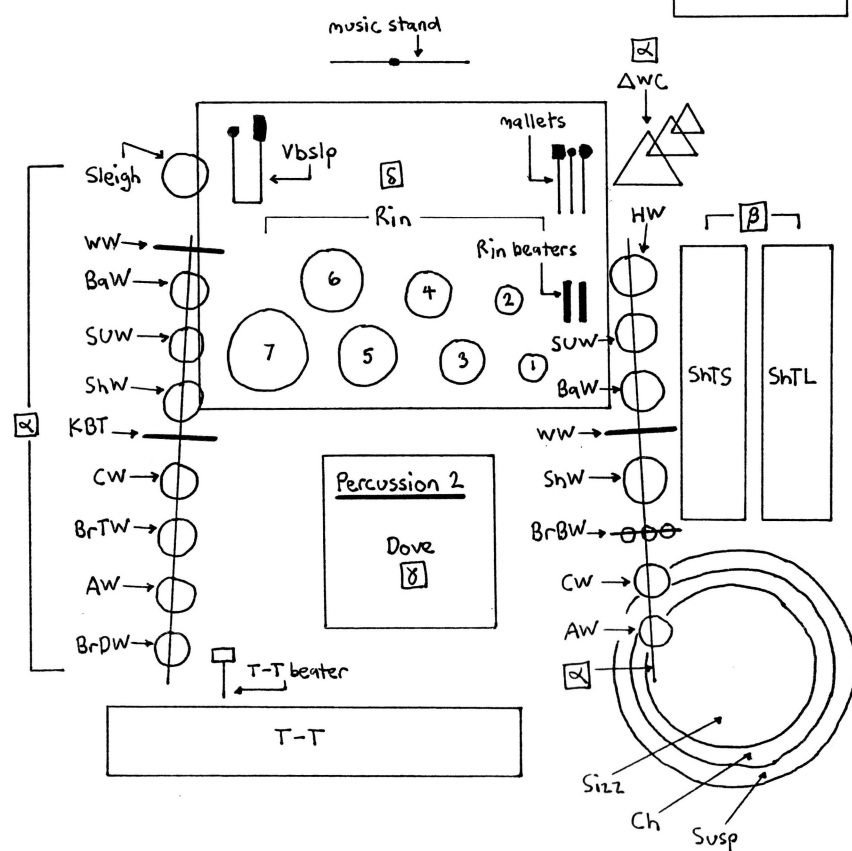
Aside from the self-evident tablature pictographs and symbology, N denotes the normal or standard fingering.

MULTIPHONICS

↑
AUDIENCE

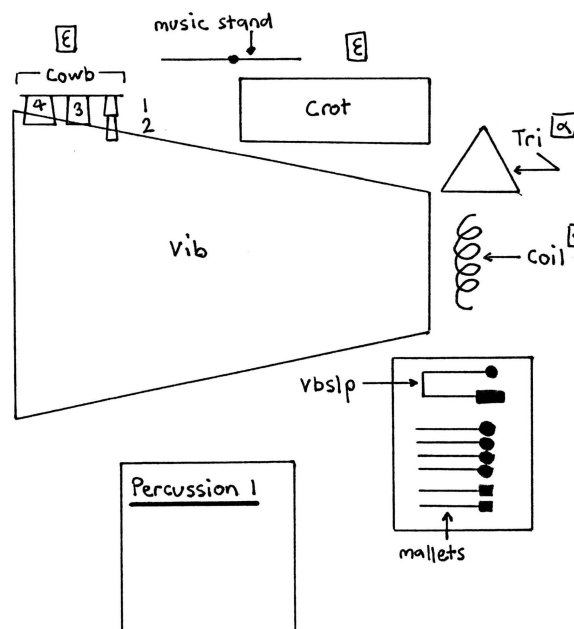
**PHYSICAL LAYOUT OF
THE INSTRUMENTS**

(not drawn to scale)



Cycles of Vega

- © Ian Shanahan, Sydney, Australia; 28 September 1991.
- To Eric Gross and Peter Sculthorpe;
 - For Rostyn Dunlop, Daryl Pratt and Tony Cowdroy to play.



- ⌘: suspended high, at about chest-height - above other instruments if necessary.
 ⌢: suspended very high - reaching at least 2 metres above the floor!
 ⓧ: hanging from a string, around the percussionist's neck!
 Ⓢ: resting upon their traditional cushions, on a (cloth-covered) table.
 ⓔ: rack-mounted.

Cycles of Vega

Cycles of Vega

♩ = 134. Wild, vibrant and ecstatic! Rhythmically precise.

Clarinet

PERC. 1

Crot

Cym

PERC. 2

Cym

Rin

Sleigh
L.H. WC

T-T

Violins

Vib

Cowb

R.H. WC

Conductor's Score

1

3

16

3

4

4

5

8

Tempo

Key Signature

Time Signature

Rehearsal Markings

Performance Notes

Clarinet

"Sneak attack": fade in the multi-
phonic quickly during the perc-
ussion flourish (if possible); the
multiphonic's onset should be com-
pletely obscured.

Percussion

Percussion: as fast, violent and brilliant
as possible - an utterly
stinging attack; cover the
clarinet multiphonic's onset.

Violins

Now hold the multiphonic ABSOLUTELY STEADY - bell-like,
well-balanced, non-vibrato! (Merge it with the percussion
resonances.)

Violins

accel...
emerging...

Violins

c.7"

Violins

c.7"

Violins

1.

A

4

a.f.a.p.

bend

3

ff

f

sffz

pp!

7

16

ff: f poss.

Imitate the sound and envelope of the vibraslap.

fast, random key-noises - f poss.

flz

5

16

f

p < mf

sffz

4

8

PERC. 1

Vbslp

Vib

Cowb

*extremely violent**

gliss.

2

f poss. ff

Sizz

5:4

mf

★ see Performance Notes, p. xi.

PERC. 2

Cym

Shw

f poss.

Sleigh

Baw

f

p

f

Shw

f poss.

Suw

3

f poss.

mp

HW

sffz

R.H. WC

Sleigh L.H. WC

tr

R tr-A

R

R

(E)

Gradually decrease the tempo to $\bullet = 65$, as indicated, dispelling the tension. ...

10 **5** **8**

2 **8**

5 **8**

7 **16**

B

PERC. 1
Vbslp
Vib
Cowb
Cym

PERC. 2
Cym
R.H. WC
Sleigh
L.H. WC

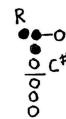
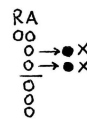
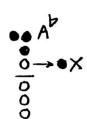
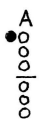
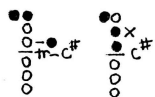
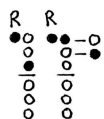
Ab
R
R tr-A
(E)

3 **a.f.q.p.** **bend**
sfz > mf **f** **< ff**
sfz **f**
pp! **ff**
f **poss.** **mf** **p: p poss.** **sfz**
extremely violent*
gliss.
Susp **5:4**
mp
as in bar 4.
Shw **Sleigh**
Shw **Sleigh**
c.13" **c.20"**
mp **ff** **ppp** **p** **ppp** **f poss.** **ppp** **f poss. : ff**

... ♩ = 131 ...

... ♩ = 129 ...

... ♩ = 127 ...



13 **7** **16** **5** **16** **4** **8**

e^b Clar.

f *p:mf* *sfz > mp:mf* *p < ff* *pp < f* *ppp* *f poss.* *omf* *p poss.*

as before... *flz*

PERC. 1

Vbslp

Cowb

Cym

sfz *mf*

PERC. 2

Cym

R.H. WC

Sleigh

L.H. WC

Shw *Baw* *HW*

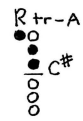
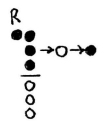
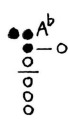
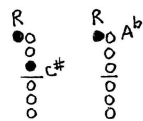
f poss. *f* *sfz*

p *ppp*

... ♩ = 124 ...

... ♩ = 121 ...

... ♩ = 119 ...



Handwritten musical score for a piece, featuring multiple staves and various musical notations.

Staff 1 (e^b Clar.): Contains melodic lines with dynamics (f, mf, p, pp, sfz, bend) and articulation (accents, slurs, trills). Includes a measure marked 16 and a section marked 5/8.

PERC. 1: Includes Vbslp, Cowb, and Cym. Cym features a measure marked 16 and a section marked 5/8.

PERC. 2: Includes Cym, R.H. WC, and Sleigh L.H. WC. R.H. WC features a measure marked 16 and a section marked 5/8. Sleigh L.H. WC features a measure marked 16 and a section marked 5/8.

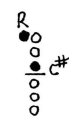
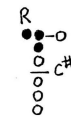
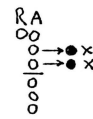
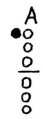
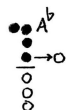
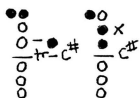
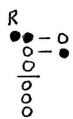
Other markings: Includes various musical symbols such as notes, rests, slurs, and dynamic markings (f, mf, p, pp, sfz, bend).

... ♩ = 116 ...

... ♩ = 115 ...

... ♩ = 111 ...

... ♩ = 108 ...



C

Handwritten musical score for multiple instruments. The score is divided into measures by vertical bar lines. The instruments and their parts are:

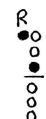
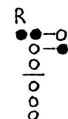
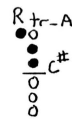
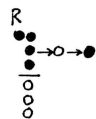
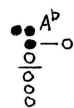
- e^b Clar.**: Main melodic line with various dynamics (mf, p, f, ppp, mp) and articulations (accents, slurs, trills). Includes a section marked **19** and a section marked **7**.
- PERC. 1**: Includes Vbslp, Vib, Cowb, and Cym. Features a section marked **5** and a section marked **7**.
- PERC. 2**: Includes Cym, R.H. WC, Sleigh, and L.H. WC. Features a section marked **5** and a section marked **7**.

The score includes various musical notations such as notes, rests, slurs, and dynamic markings. There are also handwritten annotations like "violent", "gliss.", "Sizz", "Sleighb", "Shw", and "mp (echo)".

... ♩ = 106 ...

... ♩ = 103 ...

... ♩ = 100 ...



Handwritten musical score for a 7-string guitar and percussion ensemble. The score is divided into three systems, each spanning 8 measures. The first system starts at measure 23.

PERC. 1: Vbslp, Cowb, Cym. Includes dynamics like *mf* and *sfz*.

PERC. 2: Cym, R.H. WC, Sleigh, L.H. WC. Includes dynamics like *mp*, *smfz*, *f*, *p*, *mf*, and *ppp*.

7-string guitar: Includes dynamics like *mf*, *mp*, *p*, *ppp*, and *pposs.*. Features include triplets, trills, bends, and a section marked "as before...".

Measure numbers: 23, 4, 8, 5, 8.

... ♩ = 96 ...

... ♮ = 92 ...

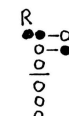
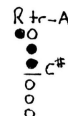
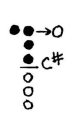
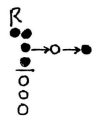
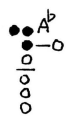
... $\perp = 90^\circ$...

Handwritten musical score for "The Sound of Silence" by Simon & Garfunkel. The score is written on a grand staff with five systems. The first system is for the vocal melody (e♭ Clarinet), the second for Percussion 1 (Vibraphone, Vibes, Cowbell, Cymbal), the third for Percussion 2 (Cymbal, Right Hand, Sleigh, Left Hand), and the fourth and fifth for the piano accompaniment. The score includes various musical notations such as notes, rests, dynamics (ppp, mp, mf, f, p, poss.), articulation (accents, glissando), and performance instructions (e.g., "huh!", "as before..."). The score is divided into measures by bar lines, with measure numbers 5, 8, 16, and 7 indicated. The score is handwritten in black ink on a white background.

... ♩ = 86 ...

... ♩ = 83 ...

... ♩ = 81 ...



Handwritten musical score for a 7-string guitar and percussion ensemble. The score is divided into three systems, each with a measure number (7, 5, 4) and a rehearsal mark (16, 16, 8).

System 1 (Measure 7, Rehearsal 16): The guitar part features a triplet of eighth notes, a trill (tr), a half note (a.f.a.p.), and a bend. The percussion part includes Vbslp, Cowb, and Cym. The R.H. WC part has a triplet of eighth notes. The Sleigh L.H. WC part has a half note.

System 2 (Measure 5, Rehearsal 16): The guitar part features a triplet of eighth notes, a half note, and a triplet of eighth notes. The percussion part includes Vbslp, Cowb, and Cym. The R.H. WC part has a triplet of eighth notes. The Sleigh L.H. WC part has a half note.

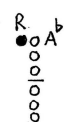
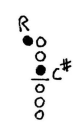
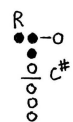
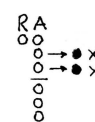
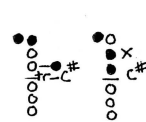
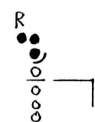
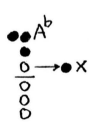
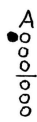
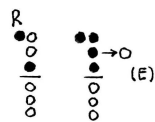
System 3 (Measure 4, Rehearsal 8): The guitar part features a half note, a triplet of eighth notes, a half note, and a half note. The percussion part includes Vbslp, Cowb, and Cym. The R.H. WC part has a triplet of eighth notes. The Sleigh L.H. WC part has a half note.

Handwritten notes and markings include: "mp > p", "p", "mp", "mp: p", "p poss.", "mp: f poss.", "mp", "as before...", "flz", "x", "K", "huh!", "Sizz", "5:4", "Shw", "SUW", "pp", "mp", "ppp", "Cym", "R.H. WC", "Sleigh L.H. WC", "Vbslp", "Cowb", "Cym", "PERC. 1", "PERC. 2", "7", "5", "4", "16", "16", "8", "29", "a.f.a.p.", "bend", "tr", "3", "mp", "p", "mp: p", "p poss.", "mp: f poss.", "mp", "as before...", "flz", "x", "K", "huh!", "Sizz", "5:4", "Shw", "SUW", "pp", "mp", "ppp", "Cym", "R.H. WC", "Sleigh L.H. WC", "Vbslp", "Cowb", "Cym", "PERC. 1", "PERC. 2", "7", "5", "4", "16", "16", "8", "29".

... ♩ = 78 ...

... ♩ = 75 ...

... ♩ = 71 ...



Handwritten musical score for multiple instruments. The score is divided into three systems, each with a measure number (32, 58, 28) in a box. The instruments are:

- e^b Clar.**: Main melodic line with various dynamics (ppp, mp, p, mf, f, poss.) and articulations (accents, slurs, triplets).
- PERC. 1**: Includes Vbslp, Cowb, and Cym. Features a "Susp" (sustained) section and a "Sizz" (sizzle) section.
- PERC. 2**: Includes Cym, R.H. WC, and Sleigh L.H. WC. Features various rhythmic patterns and dynamics.

Additional markings include "K" (key signature change), "flz" (flute), "as before...", and "huh!". The score is written on a grand staff with multiple staves for each instrument.

... ♩ = 67...

... ♩ = 65. Stable tempo.

Pause until the Tam-Tam resonance is 'mp' (approximately)

E

R
●
●
●
●
E

R
●
●
●
●
E

sporadically flick (off) the E-key, for the duration of the trill. Rand.

□ ●

35

e^b Clar.

28

PERC. 1
Vbslp
Vib
Cowb
Cym

PERC. 2
Cym
R.H. WC
Sleigh
L.H. WC
T-T

leisurely! gliss. 3

mp

pp cresc....

accel...

a.f.a.p.

... mp < mf
cut off suddenly
at the sound of Ch.
(Perc. 1).

★ damp the Ch by grasping it strongly
with either hand immediately after
striking it.

Clar.

Sizz

Susp

Ch

mf

p

mf

Shw

Shw

f poss.

★★ attack both Shw simultaneously
at the sound of Ch (Perc. 1).

Shw

f poss.

(T-T) ... mp dim.)

c. 23"

c. 1'15"

take

f!

(dim....)

Pause until the Tam-Tam resonance is 'pp'

■ **FREE DURATIONS.** One smooth gesture: react to one another in accordance with the given arrows; well-connected, continuous...

39 ★ *teeth on reed* *x* *scrape* *Ch* *Rand.* *brilliant: a.f.a.p.*

PERC. 1
Coil
Crot
Vib
Cowb
ShTL
Cym

pp *mp* *pp* *ff!*

★ A rather short, indeterminate duration - like an after-resonance. Play immediately upon hearing the Ch attack (bar 38). Teeth-on-reed: very high and steady initially, starting pure and disembodied.

Vib gliss., KBT
Vib, KBT
Vib, Cowb
brilliant but dry: a.f.a.p.

fast, raspy.
non Ped.! (throughout bar 39)

1 *3* *4* *2*
p *sffz* *f poss.!*

PERC. 2
R.H.WC
ShT'S
Rin
Sleigh
L.H.WC

Cowb 3
HW
sffz

Clar. 'mordent'
★★ coordinate precisely with Clar.

Clar. reed-scrape
KBT
mf
simultaneously with Vib gliss. (Perc. 1).

Cowb 2 *Sleigh*
= 65. *3*
★★

Place Dove between lips: unseen (as much as possible).

38

$\text{♩} = 43$. Extremely slow, distant and dream-like: timeless and inexorable, but rhythmically precise, like a huge cosmic clockwork.

F

40

barely (only just) audible.

very pure and distant.

R
O
O
O
O
O
O
tr-G#
Rand.
K

bend

flz 3 flz

e^b Clar.

p < > poss. pochiss.

ppp < > poco

ppp < p

mf: pp < mp

PERC. 1
Coil

Crot

Vib

Ped

Cowb

ShTL

Cym

PERC. 2

R.H.WC

Dove

ShTS

Rin

L.H.WC

c.19"

c.1'34"

28

sempre

3

[Ch]

ppp

[AW]

3

ppp

very delicate.

[Dove]

mf: pp

mp

try to create "beats" with the C#4 of the Vib (Perc.1).

Aim

[BrTW]

pp

pp

[CW]

pp

PERC. 1

Coil

Crot

Vib

Ped

Cowb

ShTL

Cym

PERC. 2

R.H. WC

Dove

ShTS

Rin

L.H. WC

45

e^b Clar.

5:3 F

3

echoing the Dove, Perc. 2.

ppp:mp:ppp < p

pp choppy

5:4

5

16

2

16

2

8

flz

pp

p poss.

③

①

③

①

7

sempre

2

ppp

5

mp

4

ppp

3

4

ppp

tr

7 6

p

ppp < pp > ppp

5

6

p

KBT

ppp

Handwritten musical score for Percussion 1 and Percussion 2. The score is written on a grand staff with multiple staves for different percussion instruments.

Percussion 1 (PERC. 1):

- Clarin. 2:** Staff with notes, including a grace-note "on the beat" and a 5:4 ratio. Dynamics include *p*, *pp*, and *ppp*. A wavy line indicates a tremolo or rapid oscillation.
- Coil:** Staff with notes and a 5:4 ratio. Dynamics include *p*, *pp*, and *ppp*.
- Crot:** Staff with notes and a 5:4 ratio. Dynamics include *p*, *pp*, and *ppp*.
- Vib:** Staff with notes and a 5:4 ratio. Dynamics include *p*, *pp*, and *ppp*. A wavy line indicates a tremolo or rapid oscillation.
- Cowb:** Staff with notes and a 5:4 ratio. Dynamics include *p*, *pp*, and *ppp*. A wavy line indicates a tremolo or rapid oscillation.
- ShTL:** Staff with notes and a 5:4 ratio. Dynamics include *p*, *pp*, and *ppp*.
- Cym:** Staff with notes and a 5:4 ratio. Dynamics include *p*, *pp*, and *ppp*.

Percussion 2 (PERC. 2):

- R.H.WC:** Staff with notes and a 5:4 ratio. Dynamics include *p*, *pp*, and *ppp*.
- ShTS:** Staff with notes and a 5:4 ratio. Dynamics include *p*, *pp*, and *ppp*.
- Rin:** Staff with notes and a 5:4 ratio. Dynamics include *p*, *pp*, and *ppp*.
- L.H.WC:** Staff with notes and a 5:4 ratio. Dynamics include *p*, *pp*, and *ppp*.

Handwritten Annotations:

- 5:4** (Ratio)
- tr** (Tremolo)
- a.f.a.p.** (Alto Fortissimo)
- grace-note: "on the beat"**
- 3** (Triplet)
- poco** (Poco)
- Ped** (Pedal)
- BrDW** (Bridle Drum)
- BrTW** (Bridle Drum)
- N** (Normal)
- R** (Rhythm)
- F** (Forte)

Handwritten musical score for a percussion ensemble, featuring staves for e^\flat Clar., PERC. 1 (Coil, Crot, Vib, Cowb, ShTL, Cym), PERC. 2 (R.H.WC, SHTS, Rin, L.H.WC), and other instruments. The score includes various musical notations, dynamics (pp, ppp, mp), and performance instructions such as "poetic", "bend", "very steady", and "K frequency = a simple sub-division of Vib motor rate ①". The score is divided into measures, with some measures containing large numbers (5, 16, 2, 8, 3, 8) indicating measure counts or groupings. The notation includes notes, rests, and various rhythmic markings.

Handwritten musical score for Percussion 1 and Percussion 2.

PERC. 1

- Coil**: 3/8, 2/8, 3/16, 2/8
- Crot**: 15, 7:4, 7
- Vib**: 7:4, 7, 3
- Cowb**: Ped
- ShTL**: 1, 3, 6
- Cym**: mp: p

PERC. 2

- R.H.WC**: Shw, ppp
- ΔWC**: ΔWC, ppp
- ShTS**: 3, 4, 6, 2, 4
- Rin**: 7, 7, 7, 7, 7, 7
- L.H.WC**: Shw, Suw, BaW, WW, ppp, p poss.

Handwritten Notes:

- 63
- mf > p mp p pp p poss.
- a.f.a.p.
- 7:4
- mp: p
- ppp
- Ped
- Shw
- ΔWC
- ShTS
- Rin
- L.H.WC
- ppp
- p poss.

Handwritten musical score for a percussion ensemble. The score is organized into two main sections: PERC. 1 and PERC. 2.

PERC. 1 Instruments: e^b Clar., Coil, Crot, Vib, Cowb, ShTL, Cym.

PERC. 2 Instruments: R.H. WC, ShTS, Rin, L.H. WC.

Key Performance Markings and Notations:

- PERC. 1 e^b Clar.:**
 - Measure 69: 5:4 ratio, wtr (water) effect.
 - Measures 70-72: 7:4, 3:2, and 3:2 ratios, tr-E (trill) markings, K (key) markings, and a bend.
 - Measures 73-75: flz (flute) markings, 5:4 ratio, K (key) markings, and a 3:2 ratio.
- PERC. 1 Vib:**
 - Measures 70-72: Dashed lines with circled numbers 3, 2, 4, and 1.
 - Measure 73: (subito) 2.
 - Measures 74-75: Sempres marking.
- PERC. 1 Cowb:**
 - Measure 73: 2, 6, 3 markings.
 - Measure 74: 3 marking.
 - Measure 75: 3, 4 markings.
- PERC. 2 R.H. WC:**
 - Measure 73: 5:4 ratio, 2, 3 markings.
 - Measure 74: 3 marking.
 - Measure 75: 3, 4 markings.
- PERC. 2 L.H. WC:**
 - Measure 73: 3 marking.
 - Measure 74: 3 marking.
 - Measure 75: 3, 4 markings.

Other Markings: pp (pianissimo), mp (mezzo-piano), mf (mezzo-forte), p (piano), Sizz (sizzle), Susp (sustain), and various dynamic markings like mf:p and pp:p.

Handwritten musical score for Percussion 1 and Percussion 2, featuring various instruments and dynamic markings.

Percussion 1 (PERC. 1):

- Clarin. (Clarinet):** Staff 1. Includes a 5:4 measure, a 7:4 measure with a trill (tr) and bend, and a 5:4 measure with a trill (tr) and bend. Dynamics: *p*, *pp*, *mf:f:p*, *mp:pp*, *p:ppp*, *mp*.
- Coil:** Staff 2. Includes a 5:4 measure with a 15 measure rest. Dynamics: *ppp*.
- Crot:** Staff 3. Includes a 5:4 measure with a 15 measure rest. Dynamics: *ppp*.
- Vib:** Staff 4. Includes a 5:4 measure with a 15 measure rest. Dynamics: *p*, *pp*, *ppp*. Includes a note: "★ Emphasize the G4 slightly."
- Cowb:** Staff 5. Includes a 5:4 measure with a 15 measure rest. Dynamics: *p*, *pp*, *ppp*. Includes a note: "-Ped".
- ShTL:** Staff 6. Includes a 5:4 measure with a 15 measure rest. Dynamics: *p*, *pp*, *ppp*.
- Cym:** Staff 7. Includes a 5:4 measure with a 15 measure rest. Dynamics: *p*, *pp*, *ppp*. Includes a note: "Ch".

Percussion 2 (PERC. 2):

- R.H.WC:** Staff 8. Includes a 5:4 measure with a 15 measure rest. Dynamics: *mp*. Includes a note: "Hw".
- ShTS:** Staff 9. Includes a 5:4 measure with a 15 measure rest. Dynamics: *mp*. Includes a note: "KBT".
- Rin:** Staff 10. Includes a 5:4 measure with a 15 measure rest. Dynamics: *mp*. Includes a note: "KBT".
- L.H.WC:** Staff 11. Includes a 5:4 measure with a 15 measure rest. Dynamics: *mp*. Includes a note: "KBT".

Other markings:

- 7:4:** Measure 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63, 64, 65, 66, 67, 68, 69, 70, 71, 72, 73, 74, 75, 76, 77, 78, 79, 80, 81, 82, 83, 84, 85, 86, 87, 88, 89, 90, 91, 92, 93, 94, 95, 96, 97, 98, 99, 100.
- 5:4:** Measure 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63, 64, 65, 66, 67, 68, 69, 70, 71, 72, 73, 74, 75, 76, 77, 78, 79, 80, 81, 82, 83, 84, 85, 86, 87, 88, 89, 90, 91, 92, 93, 94, 95, 96, 97, 98, 99, 100.
- 7:4:** Measure 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63, 64, 65, 66, 67, 68, 69, 70, 71, 72, 73, 74, 75, 76, 77, 78, 79, 80, 81, 82, 83, 84, 85, 86, 87, 88, 89, 90, 91, 92, 93, 94, 95, 96, 97, 98, 99, 100.

Gradually increase the tempo to ♩ = 134, as indicated,
heightening the tension...

G

86

... ♩ = 44 ...

PERC. 1

Coil

Crot

Vib

Cowb

ShTL

Cym

PERC. 2

R.H.WC

ShTS

Rin

L.H.WC

mp **p** **bend** **2** **8**

agile **tr-E** **a.f.a.p.** **very rapid** **tr** **x f poss.** **fiz** **tr-F**

pp **p** **pp** **mp:pp** **ppp** **poco** **p** **mp** **mf** **p**

15 **3** **2** **3** **3** **5 4** **3** **3** **4** **6** **1 5** **6** **4** **1 5**

Ped **Ped**

Susp **Aw** **ppp very delicate.** **SOW** **CW**

... $\bullet = 47$...

... ♯ = 48 ...

[illegible]

103

PERC. 1

Coil

Crot

Vib

Cowb

SHIL

Cym

PERC. 2

R.H.WC

SHI'S

Rin

L.H.WC

5

16

2

8

3

8

25.

$\dots = 49 \dots$

$\dots = 50 \dots$

RA

N

N: F#

3

3

3

5:4

h

tr-F

Rand. K.

bend

poetic...

flz

mf

p

mp:pp

mp

mf: p < > poco

ppp

f: p < mp

p: pp < mf

f

pp

mp

pp

Ped

7:4

E echo

3

7:4

CW

pp

p

RA
B
N:
(F)

... ♩ = 54...

... ♩ = 55...

... ♩ = 56...

115

5:4 3

e^b Clar.

PERC. 1

Coil

Crot

Vib

Cowb

ShTL

Cym

PERC. 2

R.H.WC

ShTS

Rin

L.H.WC

flz
p
f

5:4 bend
mf
poco

flz
sfz:mp

(subito)

④

Ped

2 6 3
mp

CW

3
p

5:4
2 3
p mp

CW

KBT
3
f poss!

3 4
mf:mp

Handwritten musical score for "The Great Wall" by John Williams. The score is written for a 5:4 time signature and includes the following staves and parts:

- Woodwinds:**
 - e^b Clar.** (E-flat Clarinet): Features a 5:4 time signature, a key signature of one flat, and a tempo marking of 57. The part includes a 3-measure rest, a 5-measure rest, and a 3-measure rest.
 - Vib.** (Vibraphone): Includes a 3-measure rest, a 5-measure rest, and a 3-measure rest.
- Percussion (PERC. 1):**
 - Coil:** Includes a 3-measure rest, a 5-measure rest, and a 3-measure rest.
 - Crot.** (Crotonal): Includes a 3-measure rest, a 5-measure rest, and a 3-measure rest.
 - Cowb.** (Cowbell): Includes a 3-measure rest, a 5-measure rest, and a 3-measure rest.
 - ShTL.** (Shitl): Includes a 3-measure rest, a 5-measure rest, and a 3-measure rest.
 - Cym.** (Cymbal): Includes a 3-measure rest, a 5-measure rest, and a 3-measure rest.
- Percussion (PERC. 2):**
 - R.H.WC.** (Right Hand Woodwind): Includes a 3-measure rest, a 5-measure rest, and a 3-measure rest.
 - ShTS.** (Shitl): Includes a 3-measure rest, a 5-measure rest, and a 3-measure rest.
 - Rin.** (Rin): Includes a 3-measure rest, a 5-measure rest, and a 3-measure rest.
 - L.H.WC.** (Left Hand Woodwind): Includes a 3-measure rest, a 5-measure rest, and a 3-measure rest.
- Other parts:**
 - RA:** (Right Arm): Includes a 3-measure rest, a 5-measure rest, and a 3-measure rest.
 - BB:** (Bass Bass): Includes a 3-measure rest, a 5-measure rest, and a 3-measure rest.
 - RA:** (Right Arm): Includes a 3-measure rest, a 5-measure rest, and a 3-measure rest.
 - BB:** (Bass Bass): Includes a 3-measure rest, a 5-measure rest, and a 3-measure rest.

The score includes various musical notations such as rests, notes, and dynamic markings (p, mf, mp, pp, p-imp, p-pp, p-pass). It also features a 5:4 time signature and a key signature of one flat. The score is written for a 5:4 time signature and includes the following staves and parts:

- Woodwinds:**
 - e^b Clar.** (E-flat Clarinet): Features a 5:4 time signature, a key signature of one flat, and a tempo marking of 57. The part includes a 3-measure rest, a 5-measure rest, and a 3-measure rest.
 - Vib.** (Vibraphone): Includes a 3-measure rest, a 5-measure rest, and a 3-measure rest.
- Percussion (PERC. 1):**
 - Coil:** Includes a 3-measure rest, a 5-measure rest, and a 3-measure rest.
 - Crot.** (Crotonal): Includes a 3-measure rest, a 5-measure rest, and a 3-measure rest.
 - Cowb.** (Cowbell): Includes a 3-measure rest, a 5-measure rest, and a 3-measure rest.
 - ShTL.** (Shitl): Includes a 3-measure rest, a 5-measure rest, and a 3-measure rest.
 - Cym.** (Cymbal): Includes a 3-measure rest, a 5-measure rest, and a 3-measure rest.
- Percussion (PERC. 2):**
 - R.H.WC.** (Right Hand Woodwind): Includes a 3-measure rest, a 5-measure rest, and a 3-measure rest.
 - ShTS.** (Shitl): Includes a 3-measure rest, a 5-measure rest, and a 3-measure rest.
 - Rin.** (Rin): Includes a 3-measure rest, a 5-measure rest, and a 3-measure rest.
 - L.H.WC.** (Left Hand Woodwind): Includes a 3-measure rest, a 5-measure rest, and a 3-measure rest.
- Other parts:**
 - RA:** (Right Arm): Includes a 3-measure rest, a 5-measure rest, and a 3-measure rest.
 - BB:** (Bass Bass): Includes a 3-measure rest, a 5-measure rest, and a 3-measure rest.
 - RA:** (Right Arm): Includes a 3-measure rest, a 5-measure rest, and a 3-measure rest.
 - BB:** (Bass Bass): Includes a 3-measure rest, a 5-measure rest, and a 3-measure rest.

The score includes various musical notations such as rests, notes, and dynamic markings (p, mf, mp, pp, p-imp, p-pp, p-pass). It also features a 5:4 time signature and a key signature of one flat.

... ♩ = 59 ...

... ♩ = 60 ...

... ♩ = 61 ...

R
B
O
C#
N

127

e^b Clar.

PERC. 1

Coil

Crot

Vib

Cowb

ShTL

Cym

PERC. 2

R.H.WC

ShTS

Rin

L.H.WC

T-T

mp > p
flz bend
3
ppp
mf
p

tr
f
5
16
pp < mp
bend

3
8

AW

delicate.
ppp

BaW

f

BrTW

SUW

SHW

f poss! mp mf

T-T
mp

c. 1'53"
c. 5'38"

[illegible]

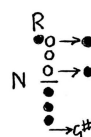
... = 71 ...

... = 72 ...

... = 73 ...

... = 74 ...

... = 75 ...



143

PERC. 1

Coil

2

8

PERC. 2

R.H.WC

ShTS

Rin

L.H.WC

e^b Clar.

Crot

Vib

Cowb

ShTL

Cym

flz bend

tr

a.f.a.p.

5:4

tr

(norm.)

a.f.a.p.

5:4

tr

mf < f

mp

sfz sfz sfz

ff: mp

pp

mp < mf

f

5:4

f

5:4

ff > f

mp

- Ped

mf

ff

mf

f poss.

f poss.

BrDW

BrTW

BrTW

5:4

mf

f: mp

mf

5:4

f poss.

... = 76...

... = 77...

... = 78...

... = 80...

... = 81...

... = 82...

149

e^b Clar.

PERC. 1

Coil

Crot

Vib

Cowb

ShTL

Cym

PERC. 2

R.H.WC

ShTS

Rin

L.H.WC

5:4 flz bend
mf > poco < f

5
16

tr-E
C#
Rand.
K
bend
mf > mp < f > mf
poco
f > mp < ff

2
8

poetic...
flz
K
tr-E
3
(G)
5:4
f sfz2:mp mf: f p:mp < f < ff

3
8

f
mf
Ped

7:4 F echo 3
f
mp

3
3
f:ff

5:4
2 3
mf

γ γ

4
ff

KBT
7:4 F
mp < f poss.

... = 92... ... = 94... ... = 96... ... = 97... ... = 99...

RA
OO
N: (F)
b ()
()

7:4 F tr-E
3:2 tr-E
3 bend

5:4 flz
3

f: p < mf < f pass.

f < fff > mf: mp: f: p < ff > poco p

Becoming extremely brilliant,
infinitely tense and violent...

7:4 7:5 E
5:4 tr-E

flz bend
tr-E
huh! K

fff > sfz: p < ff: mf < ff > poco

PERC. 1

Coil

Crot

Vib

Ped

Cowb

ShTL

Cym

Sizz

mp/mf

PERC. 2

R.H.WC

ΔWC

ΔWC mp

ShTS

Rin

L.H.WC

3

ff

2 6 3

ff

3

ff

5

f

3

ff

f pass.

3

ff

f pass.

... = 114... ... = 117... ... = 120... ... = 123... ... = 126... ... = 127... Cataclysmic!

172

PERC. 1

Clar. e^b

Coil

Crot

Vib

Ped

Cowb

ShTL

Cym

PERC. 2

R.H.WC

Δ WC

ShTS

Rin

L.H.WC

T-T

extremely intense.

fff

f poss.

ff

f poss. mp!

ff

poca

f poss. ...

5:4

gliss.

f poss.

gliss.

f poss.

Ped

forceful!

gliss.

6

f poss.

4

5

fff

★ "wall of sound": the action must be extremely aggressive and violent!

★ ★ Collide all Shan Tubes together in an absolutely violent manner. Continue to agitate them from time to time, causing random attacks between ALL Shan Tubes: a 'super windchime'!

AW

brilliant and starry.

f poss.

★ ★

sttz cataclysmic!

AW

brilliant and starry.

f poss.

ff! (dim...)

37

Pause until the overall dynamic of the Percussion resonances is 'mf' (approximately)

38.



♩ = 67. Starry and shimmering: dynamically well-balanced; precise; very intense, but becoming more and more mellow. Decrease the tempo to ♩ = 40, as indicated, dispelling the tension...

Handwritten musical score for a percussion ensemble. The score is divided into five measures, each with a large measure number (2, 3, 2, 2, 2) and a large time signature (8, 8, 8, 16, 8). The instruments are listed on the left: e^b Clar., PERC. 1 (Coil, Tri, Crot, Vib, Cym), and PERC. 2 (Δwc, Rin). The score includes various musical notations such as notes, rests, dynamics (sfz:mp, ff, mf, f, p, mp), articulations (bend, vibrato), and performance instructions (Rand., [repet to Vib vibrato as you wish], gently agitate). Above the first measure, there are tempo markings: ♩ = 66..., ♩ = 64..., ♩ = 62..., ♩ = 61..., and ♩ = 60... with corresponding musical notation. The score is heavily annotated with handwritten notes and markings, including "J", "180", "N", "huh!", "bend", "poco", "Susc", "Ped", "Δwc", and "gently agitate".

... = 59...

... = 58...

... = 57...

... = 56...

... = 55...

... = 54...

Handwritten musical score for multiple instruments and percussion.

Top Staff: Treble clef, key signature of one flat. Notes are marked with dynamics: *f*, *mf*, *mp*, *pp*, *p*, *mp*, *p*. Includes a **bend** instruction and a **5:4** ratio marking. A **tr-any** instruction is present above the staff.

PERC. 1: Includes **Coil** and **Tri**. Notes are marked with *mf*. Includes a **Ped** (pedal) instruction.

PERC. 2: Includes **Rin**. Notes are marked with *f*, *mf*, *mp*. Includes a **Ped** instruction.

Other Percussion: **Crot**, **Vib**, **Cym**. Includes a **Ped** instruction.

Annotations:

- ★ grace-note: "on the beat".
- ★★ as in bars 180-181.
- fade in the multiphonic - legatissimo! - if possible, between the two single component-pitches.
- [K]** as in bars 180-181...
- [Ch]**
- [C.22']** **[c.7'19"]**

Bottom Staff: Treble clef, key signature of one flat. Notes are marked with dynamics: *f*, *mf*, *mp*. Includes a **Ped** instruction.

...♩ = 53... ...♩ = 52... ...♩ = 51... ...♩ = 50...

PERC. 1
Coil
Tri
Crot
Vib
Cym

PERC. 2
Rin

192 **3** **8** **2** **8** **2** **16** **2** **8**

41

mp p p: mp pp < > poco mf sfz: ppp mf mf pp p mf pp Ch ppp (p poss.)

Rand. ~K x Rand. fliz 5:4 huh! 7:4 5:4 bend J wavy bend fliz 5:4 5:4


★ grace-note: "on the beat".
★★ as in bars 180-181.

An (uncoordinated) interruption in the process, like a brilliant, blinding, coruscative wave of light!

Handwritten musical score for a percussion ensemble, featuring five staves: **e^b Clar.**, **PERC. 1** (Coil, Tri, Crot, Vib, Cym), and **PERC. 2** (Rin). The score is divided into measures by vertical bar lines, with large numbers **3 8**, **2 8**, **2 16**, and **2 8** indicating measure counts or groupings.

Key Annotations and Performance Instructions:

- Tempo/Beat Markings:** $\dots \bullet = 45 \dots$, $\dots \bullet = 44 \dots$, $\dots \bullet = 43 \dots$
- Clarinet Part:** Includes notes with slurs, dynamic markings (*ppp*, *p*, *sfz: ppp*, *pp*, *p poss.*), and articulation like *bend* and *poco*. A box labeled **204** is present.
- Percussion 1 Part:** Includes *Coil*, *Tri*, *Crot*, *Vib*, and *Cym*. Markings include *pp poss.*, *Ped*, *Susp*, *Sizz*, and *ppp*.
- Percussion 2 Part:** Includes *Rin*. Markings include *pp*, *p*, *p (m)p*, and *pp*.
- Measure Groupings:** Ratios like $5:4$ and $7:4$ are written above notes.
- Performance Notes:** "huh!", "teeth on reed", "extremely piercing", "chaotic! - but one smooth gesture.", and "immediately cut off the sound by suddenly removing the clarinet's mouthpiece from between the lips!".
- Visual Elements:** A diagram of a clarinet mouthpiece is labeled "suspended time". A diagram of a reed is labeled "scrape". A diagram of a reed is labeled "teeth on reed". A diagram of a reed is labeled "extremely piercing". A diagram of a reed is labeled "c. 2''". A diagram of a reed is labeled "c. 5'' DO NOT MOVE!". A diagram of a reed is labeled "c. 7'' DO NOT MOVE!". A diagram of a reed is labeled "c. 7'' DO NOT MOVE!".

...  = 40. Stable tempo.

44.

J. S. Hawala. Sydney, Australia, 28 September 1991.
(This score copied January - March 2002.)

Cycles of Vega

- To Eric Gross and Peter Scutthorpe.
- For Ros Dunlop, Daryl Pratt and Tony Cowdroy to play.

† Maintain your physical attitude for approximately ten seconds: do not move until all other resonances are lost in the distance then relax!

Pause until the Tam-Tam resonance is 'ppp' (approximately) ♩ = 40.

PERC. 1
Coil
Tri
Crot
Vib
Cowb

PERC. 2
Vbslp
RH.WC
L.H.WC
T-T

215 ♩ = 40.

pure
h
K

ppp... (absolutely steady!)

5
16

5
32

flz
huh!★

c.10"†

★ answer and imitate the (envelope of) the vibroslap.
■ suddenly pull the mouth-piece from between the lips.

P ped.

non ped!

mf! 'insistent'

furtively: □; take up Vbslp.

KBT

echo

pp (dim...) ppp

(T-T) ... ppp

c.10"†

c.10"†

c.26" 3/4!

45.

FINE.

CHAPTER 5. ... AND LIGHT FROM THE SUN: RAINBOWS, *GEMATRIA*, PROPORTIONS AND SELF-SIMILARITY

5.1 LINES OF LIGHT: SEVEN IMPROVISATIONS ON *αιθερος μελος*

5.1.1 FURTHER ANALYTICAL NOTES¹

Preamble: Composing as an Act of Love

I recall several reasons why **Lines of Light: Seven Improvisations on *αιθερος μελος*** was conjured into existence. But beyond those that seem obvious – such as its formal commissioning by the ensemble *austraLYSIS* – and my intention that **Lines of Light** would endure as a ‘sonic myth of Creation’ (a cosmogony whose substances evolve from primal ‘chaos’ to ‘order’), there remains a very personal, magnanimous purpose behind its composition.

My Programme Annotation for **Lines of Light: Seven Improvisations on *αιθερος μελος*** mentions its dedication to the memory of Mrs Barbara Burke, a Christian missionary killed in Jerusalem on 23.5.1991. Her son, my close friend Ross Burke, was on the verge of suicide over his mother’s untimely death – and so my first version of the piece (titled ***αιθερος μελος* – Microcosm**, for e♭ clarinet, percussion, and contrabass ... now withdrawn) served as a kind of psychotherapy for Ross, whose extremely keen interest in my work-in-progress, and eagerness to experience its world première in late 1991, to some extent outstripped the self-destructiveness of his grief. (Ross still continues to champion **Lines of Light**.)

*The Partial Scorelessness of Lines of Light: Seven Improvisations on *αιθερος μελος**

Because interactive cueing and various degrees of temporal independence or elasticity amongst the performers are integral to the conception of **Lines of Light: Seven Improvisations on *αιθερος μελος***, as is the delimited aleatoric treatment of many specific performance parameters, I have (perhaps surprisingly) decided that any attempt by me to furnish a coordinated and comprehensive ‘full study score’ of this piece would be a rather pointless and self-defeating exercise: so, the documentation of certain of this piece’s earlier “improvisations” resides solely in the three separate instrumental parts, rather than ‘in score’. One is therefore able to perceive a teleological progression from non-coordinated barlessness – i.e. an absence of temporal gridding – in **Improvisation 1**,

to a fully-barred synchrony in **Improvisation 7**.

In the spirit of Chris Dench's quintet **Heterotic Strings** (1993) – a completely scoreless work that received its world première by *austraLYSIS* at the very same concert as my **Lines of Light: Seven Improvisations on αιθερος μελος**, on 27.11.1993 – I hold the opinion that

Despite the lack of score or coordination, this is not an “indeterminate” work: all the sounds, and the order and duration of their occurrence, are fully composed. What is not determined are the vertical coincidences of events, the simultaneities. But then, this is to a varying degree true of all my music. The [instrumental parts are] prefaced by a caveat: “In Superstring Theory a heterotic string is a closed loop form which exhibits a direction-dependent (“clockwise” / “anticlockwise”) dimensionality. What this means, except mathematically, is, as far as I know, not understood...” This polydimensionality expresses itself in the musical text primarily through the inevitable differences between one performance and another, but also in the structural elasticities of the individual voices. Just as in Superstring Theory the strings generate the subatomic world, here the separate sounds cause electronically-generated afterimages which detail the harmony of the piece's macroform. ...²

Pitch Organization in Lines of Light: Seven Improvisations on αιθερος μελος

Apart from certain recorder tones, all of the pitch-material in my **Lines of Light: Seven Improvisations on αιθερος μελος** derives from a no-longer-available trio, **αιθερος μελος – Microcosm**, composed during 1991: **Improvisation 7** from **Lines of Light** is a fairly faithful account – indeed, a ‘transcription’ – of this now-suppressed fragment.

Anyway, while planning **Lines of Light: Seven Improvisations on αιθερος μελος**, I carefully analysed the harmonic content of **αιθερος μελος – Microcosm**, wrote it down in a distilled form, and then broke it up into eight ‘fields’ (which **Improvisation 7** steps through, in succession). These ‘harmonic fields’ – or pitch-reservoirs – are arrayed below; their four staves correspond to the e♭ clarinet, tuned percussion, and contrabass parts of **αιθερος μελος – Microcosm**. Now unlike most other facets of **Lines of Light**, those pitches within these ‘reservoirs’ are on no account the end-product of some fancy ‘precompositional system’ or rigorous algorithmic process, being created instinctively – ‘by ear’.³ Nevertheless, they do exhibit a certain intervallic consistency which could well be thought of as merely one aspect of my style, ‘ear’, or composerly idiolect. Major 7ths, minor 9ths (and their compounds), as well as major 2nds – perhaps revealing some influence of jazz, from my youth? – tend to preponderate statistically over other intervals in the harmony; but perfect 4ths and 5ths appear rather frequently, too:

field 7

The musical score for field 7 consists of four staves. The top staff is in treble clef and contains several measures with notes and rests, including a measure with a sharp sign. The second staff is also in treble clef but is mostly empty. The third staff is in treble clef and contains complex musical notation with many notes and accidentals. The bottom staff is in bass clef and contains notes and rests.

field 8

The musical score for field 8 consists of four staves. The top staff is in treble clef and contains notes and rests. The second staff is also in treble clef and contains notes and rests. The third staff is in treble clef and contains complex musical notation with many notes and accidentals. The bottom staff is in bass clef and contains notes and rests.

We know that in each of the first six “improvisations” from **Lines of Light: Seven Improvisations on αιθερος μελος**, there are seven subsections. Now since I wanted to establish a one-to-one correspondence between these subsections and the eight ‘harmonic fields’ above, it proved necessary for me to merge certain pairs of ‘fields’. Thus I developed four distinct solutions to this problem:

Harmonic Fields, as deployed throughout <i>Lines of Light</i>							
New Field-Name	F1	F2	F3	F4	F5	F6	F7
[2, 3]	1	2+3	4	5	6	7	8
[3, 4]	1	2	3+4	5	6	7	8
[4, 5]	1	2	3	4+5	6	7	8
[5, 6]	1	2	3	4	5+6	7	8

So, for example, [5, 6] conflates fields 5 and 6 from my eight original ‘harmonic fields’: within solution [5, 6], fields 1, 2, 3 and 4 remain just as they were before; F5 comprises fields 5+6; F6 and F7 consist of fields 7 and 8, respectively.

F1 to F7, all derived from **Improvisation 7**, form the harmonic basis for the rest of **Lines of Light: Seven Improvisations on αιθερος μελος**: just like a rainbow, **Improvisations 1 to 6** refract (albeit permutatively) the entire luminous ‘harmonic image’ projected by **Improvisation 7**. But I must emphasize that throughout the first six “improvisations” from **Lines of Light**, a certain amount of leeway was taken with these ‘harmonic fields’: although the fields themselves always remain recognizable (both aurally and optically, in notation), they have often been embellished with extra notes, or instead, pitches may be omitted. Each manifestation of any particular ‘harmonic field’ will always be quite different to the others. Moreover, such variety has the potential to be considerably developed by my various “randomized parameters”, which frequently allow performers the option of adding “unspecified material”.

Within **Lines of Light: Seven Improvisations on αιθερος μελος**, my ‘harmonic fields’ F1 to F7 are re-ordered by permutations from the cyclic group $\langle \Pi \rangle$, where

$$\Pi = (1, 6, 4, 2) (3, 5, 7). \text{ (Hence: } \Pi^{12} \equiv \Pi^0 = [1, 2, 3, 4, 5, 6, 7]. \text{)}$$

The tabulation below displays the global harmonic structure of **Lines of Light: Seven Improvisations on αιθερος μελος**. For each “improvisation” and instrumental part, it shows the ‘harmonic fields’ F1 to F7 in the order that they appear, as well as the specific conflation and permutation utilized. Any liberties which I took with this permutational ‘system’ have been footnoted beneath the table. Observe that during **Improvisation 7**, every instrumentalist advances through the eight original (nonconflated) ‘harmonic fields’

in strict succession:

Improvisation	1	2	3	4	5	6	7
Recorder	S _{6,6} F	S _{4,1} F	<i>tacet</i>	S _{3,1} — F6	<i>tacet</i>	S _{1,6} — ??? † F1	
	S _{6,2} R	S _{4,4} R		S _{3,4} — F1		S _{1,2} — ??? F2	
	S _{6,3} A	S _{4,2} A		S _{3,2} — F3		S _{1,3} — ??? F3	
	S _{6,4} C	S _{4,3} C		S _{3,3} — F2		S _{1,4} — ??? F4	
	S _{6,5} T	S _{4,5} T		S _{3,5} — F5		S _{1,5} — ??? F5	
	S _{6,1} A	S _{4,6} A		S _{3,6} — F4		S _{1,1} — ??? F6	
	S _{6,7} L	S _{4,7} L		S _{3,7} — F7		S _{1,7} — ??? F7	
	S *	S *		— □ ⁹			F8
				[2, 3]			□ ⁰
Yamaha DX7s	S _{6,1} — F1	interjections	S _{2,6} — F4	S _{3,1} — F6	S _{5,6} — F4	<i>tacet</i>	F1
	S _{6,4} — F2	F7	S _{2,3} — F6	S _{3,4} — F1	S _{5,4} — F6		F2
	S _{6,2} — F3	F1	S _{2,4} — F7	S _{3,2} — F3	S _{5,2} — F3		F3
	S _{6,3} — F4	F2	S _{2,2} — F1	S _{3,3} — F2	S _{5,3} — F1		F4
	S _{6,5} — F5	F4	S _{2,5} — F3	S _{3,5} — F5	S _{5,5} — F5		F5
	S _{6,6} — F6	F8	S _{2,1} — F2	S _{3,6} — F4	S _{5,1} — F2		F6
	S _{6,7} — F7	F3	S _{2,7} — F5	S _{3,7} — F7	S _{5,7} — F7		F7
	— □ ⁰	F6 ‡	— □ ²	— □ ⁹	— □ ⁶		F8
	[2, 3]		[2, 3]	[2, 3]	[4, 5]		□ ⁰
Percussion	S _{6,6} — F1	interjections	S _{2,6} — F4	S _{3,1} — F6	<i>tacet</i>	S _{1,6} — F4	F1
	S _{6,3} — F2	F7	S _{2,3} — F6	S _{3,4} — F1		S _{1,2} — F6	F2
	S _{6,4} — F7	F1	S _{2,4} — F7	S _{3,2} — F3		S _{1,3} — F7	F3
	S _{6,2} — F4	F2	S _{2,2} — F1	S _{3,3} — F2		S _{1,4} — F[1] §	F4
	S _{6,5} — F3	F4	S _{2,5} — F3	S _{3,5} — F5		S _{1,5} — F3	F5
	S _{6,1} — F6	F8	S _{2,1} — F2	S _{3,6} — F4		S _{1,1} — F[2] §	F6
	S _{6,7} — F5	F3	S _{2,7} — F5	S _{3,7} — F7		S _{1,7} — F5	F7
	— □ ⁸	F6 ‡	— □ ²	— □ ⁹		— □ ²	F8
	[3, 4]		[2, 3]	[2, 3]		[4, 5]	□ ⁰

* Each of the prepared alto recorder's 'fractals' here are flickering agglomerations of pitches, elicited using just a single fingering-configuration. Such 'fractalous sonorities' remain completely independent of all 'harmonic fields' and the cyclic group $\langle \square \rangle$.

† The tenor-recorder pitches in **Improvisation 6** are 'freely composed', being autonomous with respect to the 'harmonic fields' and cyclic group $\langle \square \rangle$.

‡ Within **Improvisation 2**, this is the order in which these (nonconflated) 'harmonic fields' are laid out in the parts. In live performance, only four or five 'interjections' are chosen from a menu of eight; the players themselves agree beforehand upon their own sequence of 'interjections'.

§ For the fourth and sixth subsections from **Improvisation 6**, the percussion instruments are silent. However, F1 and F2 are 'implied' by these silences, because the only permutation from $\langle \square \rangle$ that begins with [4, 6, 7, ...] is $\square^2 = [4, 6, 7, 1, 3, 2, 5]$.

ENDNOTES

1. Many analytical observations about **Lines of Light: Seven Improvisations on αιθερος μελος** have already been made within Chapter 1.
2. Chris Dench: **Heterotic Strings**, Programme Annotation; quoted from the Concert Programme for the *austraLYSIS* concert “Redesigning the System”, held at the Joseph Post Auditorium, the Sydney Conservatorium of Music, Sydney, on 27 November 1993.
3. As a composer, I do remain somewhat wary of that type of ‘intuition’ which is memory-based and often just regurgitates already learned patterns. ‘Intuition’, in many such cases, is simply synonymous with mental laziness or even a poverty of imagination. Rather, I strive to avoid musical clichés and stagnation at any cost.

Ian Shanahan (1991/1993)

– *In Memoriam Barbara Burke (27.9.1931 – 23.5.1991)*

For Roger Dean and Daryl Pratt to play with me:

Lines of Light
Seven Improvisations on αιθερος μελος
for
amplified recorders (1 player),
two Yamaha DX7 keyboard synthesizers (1 or 2 players),
and
metallic percussion instruments (1 or 2 players)

PROGRAMME ANNOTATION

Lines of Light: Seven Improvisations on αιθερος μελος

for amplified recorders, two Yamaha DX7 keyboard synthesizers,
and metallic percussion instruments

Ian Shanahan (1991/1993)

My title "Lines of Light" is appropriated from a novel of the same name by Daniele Del Giudice, consisting almost entirely of a dialogue between a novelist and a theoretical physicist. I have been able, with this title, to genuinely imbue the work with meaning at a number of levels. Metaphorically, **Lines of Light** invokes the notion of solar spectra, as manifested by the phenomenon of the arcing rainbow which appears to comprise seven colours and various Fraunhofer absorption lines (dark spectral bands – suppressed frequencies – evincing the coolness of the Sun's surface compared to its much hotter core). Hence, this piece embraces seven sections, all but the last being proportioned according to the relative wavelengths of Fraunhofer lines A to H. (The fact that there are only three primary colours is mirrored by the minimum number of players.) Moreover, I would hope that the sounds themselves which emanate from my unusual instrumental array provoke, within the listener's mental landscape, various images of light.

Beyond this physical metaphor, I have extensively utilized more ancient and mystical associations with the word/ikon of light. The final section of **Lines of Light**, *αιθερος μελος* (*aitheros melos*: "Music of the Spheres") – a transcription from an earlier version of this piece – exhibits a temporal organization and proportions which are determined by *gematria*, the Ancient Greek (and Jewish) Kabbalistic system of isopsephial equivalence between word and number that demonstrates various geometrical truths, and ascribes arithmetically a network of hidden connections to otherwise distinct words and archetypes. (In addition to certain Gnostic texts, the sacred hermetic writings of the Platonists and Pythagoreans – as well as the Holy Scriptures in the New Testament – are all supersaturated with the silent, mysterious truths of 'number'.) On the other hand, the first six "improvisations" in **Lines of Light** – whose basis-materials nonetheless stem from the fully composed *αιθερος μελος* – were planned to fill out 485 seconds, proceeding from 'chaos' to 'order'. (485 ≈ IEOY, the Greek mystics' *Tetragrammaton*, equivalent to the *OM* of Eastern cosmogony. Also, not insignificantly ... 485 ≈ Ο Παναγιος: The All-Holy.)

Lines of Light: Seven Improvisations on αιθερος μελος, commissioned by the neoteric new-music ensemble *austraLYSIS* with funds from the Performing Arts Board of the Australia Council for the Arts, is dedicated to the memory of Barbara Burke – an Australian Christian worker murdered in Jerusalem during the early 1990s. Her name, together with various Biblical epigrams on 'light' (φως: *phos*), is cryptically encoded into the music. (I do trust that Mrs Burke would have approved of the esoteric Christian imagery!)

© Ian Shanahan, Sydney, Australia; 3 November 1993.

Lines of Light: Seven Improvisations on αιθερος μελος was premièred by Ian Shanahan (amplified recorders), Roger Dean (Yamaha DX7 keyboard synthesizers), and Daryl Pratt (percussion), during an *austraLYSIS* concert – "Redesigning the System" – held at the Joseph Post Auditorium, Sydney Conservatorium of Music, Conservatorium Road, Sydney, on 27 November 1993.

A recording of **Lines of Light: Seven Improvisations on αιθερος μελος**, played by the same personnel, is now commercially available on the Compact Discs "Lines of Light" (Broad Music Records Jade JAD CD 1091) and "Harmonia" (SIDEREAL Records SRCD01).

PERFORMANCE NOTES

PREAMBLE

I wish to thank *Roger Dean* for his patience in demonstrating to me, prior to composing **Lines of Light: Seven Improvisations on αιθερος μελος**, the new features of his Yamaha DX7 Series II model (relative to the original Series I Yamaha DX7, with which I was already very familiar). I am also indebted to *Daryl Pratt* who, as usual, was keen to share his immense knowledge of the percussion genre and how to compose intelligently with it: for example, in deciding upon the layout of the metallic percussion instruments in **Lines of Light**, Daryl's expert advice was invaluable. I thank him for his affable generosity.

1. GENERAL REMARKS

INSTRUMENTATIONAL REQUIREMENTS, AND THE NUMBER OF PLAYERS

• **Amplified Recorders** (1 player)

- prepared alto recorder *
- soprano recorder
- keyless tenor recorder †

• **2 Yamaha DX7 Keyboard Synthesizers** (1 or 2 players)

- DX7 I: a Yamaha DX7 Series I (or Series II)
- DX7 II: a Yamaha DX7 Series II ‡

Note: both of these Yamaha DX7 keyboard synthesizers must have a *foot switch pedal* (i.e. a 'sustain pedal', for *sustain on/off*) and a *foot controller pedal* (i.e. a 'volume pedal', for varying the *volume*) connected to them.

• **Percussion** (1 or 2 players [and an *optional* assistant who shall control the vibraphone's vibrato])

- tubular bells
- 7 Japanese temple bells (*rin*)
- Chinese bell tree
- large autocoil
- 'triangle windchime' (3 triangles)
- 2 (or more) brass-tube windchimes
- crotales (the lower octave)
- vibraphone (*optional*: employ an assistant to regulate its rate of vibrato)

Note: detailed descriptions of all of these metallic percussion instruments shall be given later; I have also appended to these Performance Notes a diagram depicting their *physical layout*.

* Complete instructions for the alto recorder's preparation are provided below.

† It is imperative that the tenor recorder be *keyless*: several tenor recorder sonorities within **Lines of Light: Seven Improvisations on αιθερος μελος** can be produced *only on a keyless instrument!* (Because the keyless tenor recorder is slightly shorter than models possessing one or two keys, so that the keyless tenor recorder's bore is somewhat more conical, its intervals between successive vibrational modes tend to be 'stretched' a little by comparison with those generated by a more cylindrical bore: for instance – considering the final gesture of **Lines of Light** – overblowing the lowest C₄ of a keyless tenor recorder yields a minor-9th multiphonic, whereas on a keyed instrument, a very different 'split octave' sonority will probably ensue. Further, being more versatile in negotiating contemporary recorder techniques such as glissandi/portamenti and microtones, a majority of players prefer the keyless tenor recorder in performing twentieth-century repertoire.)

‡ I have stipulated a *Series II* Yamaha DX7 here primarily because it possesses – amongst other things – a 'split-key' faculty: i.e. on a solitary synthesizer keyboard, a *pair* of distinct 'voices' can be played, separately, upon discrete sets of keys, the 'split-key' defining the boundary between such (single) 'voices'; this 'split-key' option is used crucially in the fourth and seventh sections of **Lines of Light**. Therefore, if a Series II Yamaha DX7 is unobtainable, then a second keyboardist will definitely be required to play upon *two* Series I Yamaha DX7 synthesizers, with the original keyboardist utilizing a *third* Yamaha DX7 Series II! Alternatively, as Yamaha DX7 keyboard synthesizers (though ubiquitous throughout most of the 1980s and '90s) become increasingly rare in the future, some more recent (Yamaha) digital FM-synthesis devices – including 'software synthesizers' like Native Instruments' **FM7** – that can reproduce Yamaha DX7 voices *exactly* may be employed instead to realize this piece.

TEMPORAL ORGANIZATION, AND INTERPRETATION

Lines of Light: Seven Improvisations on αιθερος μελος embraces seven sections, 1 to 7, these section-numbers being clearly drawn within *bold boxes*; the sections themselves are bounded by *bold bar-lines*. Each section as usual comprises several bars (demarcated by regular bar-lines), but with *all* bar-lengths throughout **Lines of Light** being defined in *seconds* rather than in 'beats'. (The number written within a rectangular box above the staff at the start of each bar therefore indicates that bar's duration *in seconds*.) Please observe that bar-lines of whatever type in themselves *never* imply any pauses, disconnections or caesurae, however ephemeral – unless otherwise indicated. Note also that within section 1 of **Lines of Light**, each part has its own sequence of bar-lengths different from (indeed, a permutation of) those of the other parts, so that – aside from the first two bars – the bars' beginnings therein are not at all coordinated: across all parts within section 1, each part's bar-lengths evolve quite autonomously, not being synchronized together. In section 2 of **Lines of Light** however, the recorder part unfolds bar by bar, independently, against *coordinated* but temporally indeterminate "interjections" – notated in large bold boxes – from the other parts.

Sections 3, 4, 5, 6 and 7 in **Lines of Light** are notated entirely in *time-space notation*, so that the relative widths of bars written into each part conform directly with their relative durations. Therefore, at least as a starting-point, musical events in these sections are to be deployed chronometrically in direct proportion to their relative horizontal placement upon the score-page. Yet 'pure' time-space notation is intrinsically optical and rather imprecise (because it naturally precludes total chronometric accuracy), and so triggers a somewhat freer interpretative approach towards time by performers – who will often need to flesh out local durational nuances herein. However, in order to increase the likelihood of executative durational precision within sections 6 and 7 of **Lines of Light**, these final two sections also engage numbered 'ictuses' (short, thick vertical strokes) corresponding to *one second* of elapsed time, according to the formula *25.4 millimetres (i.e. 1 inch) ≈ 1 second = metronome 60*. Within such a framework of temporal proportionality in the recorder part, *beams* depict (local) durations – the end of a beam indicating a cessation of breath, the termination of a (previously sustained) note.

An electronic metronome flashing once per second might prove to be an effective practice tool in keeping track of time within **Lines of Light's** proportionalized chronomorphology. (Yet any sense of metricated rigidity, or blatant pulsedness, is strongly discouraged!) Furthermore, I do firmly recommend that in concert, every player be able to see plainly such a flashing metronome; yet it is also essential that the passing seconds be 'corporealized' – i.e. *felt* with the *body* – so that in live performance, any visual references to a flashing metronome are minimal, being made only when it is considered absolutely necessary.

The following table summarizes the temporal schemata and notations that I have adopted within each section of **Lines of Light: Seven Improvisations on αιθερος μελος**:

Section	Proportional bar-lengths?	Ictuses utilized?	Independent bar-lengths across all parts?
1	No	No	Yes
2	No	No	'Yes': recorder against <i>coordinated</i> interjections
3	Yes	No	No
4	Yes	No	No
5	Yes	No	No
6	Yes	Yes	No
7	Yes	Yes	No

Grace-note groups all lie 'outside time' – locally independent of the time-space paradigm and any other durational mechanisms. In general, they should be played quite rapidly or even 'as fast as possible' (i.e. as [very] short indeterminate durations, left to the discretion of the player) – although tenuto markings may be used to suggest a more leisurely approach. Indeed, nuances in horizontal spacing amongst grace-notes propound a correspondingly delicate rhythmic interpretation that is, notwithstanding, left to the discretion of the executant to some extent. Furthermore, despite their autonomous unfurling, grace-notes ought not to be thought of as mere 'ornaments', of secondary architectonic status, to the 'main notes': *all* sonorities in **Lines of Light** are equally important!



– a *decelerando* within the grace-note grouping.

PAUSES

Unless otherwise indicated, precise durational details of pauses are left to the interpretation of the performers. The following symbology is employed:

◌ is a *comma*, denoting a *slight caesura* – not necessarily for the purpose of taking a breath;

Λ is a *peaked fermata*, denoting a *relatively brief pause* (increasing a specific duration – such as the *ca.4*" static "suspended time" segment towards the end of section 7 – by no more than a factor of 2);

◻ is a *squared fermata*, denoting a *relatively lengthy pause* (increasing a specific duration by at least a factor of 2.5).

CUEING ONE ANOTHER

Throughout each part in **Lines of Light: Seven Improvisations on αιθερος μελος**, instructions are provided for *cueing one another* – to *coordinate, at a given moment, the attack (or the ending) of a sonority with another player or instrument*. Such instructions occur in two cognate forms:

- a *large bold arrow pointing downwards*, which signals the instant when *everybody* must coordinate with one another (NB: this 'generalized cue' occurs almost exclusively within the final [tutti] section of **Lines of Light**, section 7);
- when such an arrow also has *the name of another part or another instrument written directly above it*, the performer must coordinate with that particular player or instrument (only) at the given instant.

All executants are encouraged to discover, thence to notate within their own parts, additional points in the music when cueing one another might prove salutary.

DYNAMIC INDICATIONS

Apart from the traditional dynamic indications (*ppp, pp, p, mp, mf, f, ff, fff*), the following symbols are employed in **Lines of Light: Seven Improvisations on αιθερος μελος**:

○ represents the final vanishing into *inaudibility*: allow the sound to resonate, or attenuate, to *silence*;

p poss. and *f poss.* are abbreviations for 'as soft as possible' and 'as loud as possible', respectively;

certain passages in **Lines of Light** are assigned a general *dynamic range*, including the minimum and maximum permissible dynamic levels: e.g. *p↔mf*, between these limits, players are free to select and shape dynamic levels and contours for themselves.

ARPEGGIATION



– *arpeggiate* the notes in a somewhat leisurely manner.

– *rapidly* arpeggiate the notes of the chord.

For both forms of *arpeggiation*, their speed of execution is left to the discretion of the player. *Arrowheads* upon the above symbols indicate the *direction* of the arpeggio's action: ↑ = play the *lowest pitch* of the chord first; ↓ = play the *highest pitch* of the chord first.

PITCH DESIGNATION

In any textual references to pitch herein:

"Middle C" [i.e. MIDI note number 60] shall be designated as C♯3, the C♯ one octave higher as C♯4, etc. (i.e. assuming that A♯3 = 440 Hz, then C♯3 ≈ 261.6255653 Hz).

♯ and ♭ denote a *quartertone above* ♯, and a *quartertone below* ♯, respectively. Smaller degrees of intonational deviation – slight microtonal inflections, non-tempered, of up to about an eighthtone – upwards and downwards are indicated by upward-pointing and downward-pointing arrowheads, respectively, upon accidental symbols. Examples: B♯5; F♯4; A♭3; G♯2 etc.

RANDOMIZED PARAMETERS

Within each of the three instrumental parts which comprise **Lines of Light: Seven Improvisations on αιθερος μελος**, a number of technical/musical parameters are bracketed thus: *Rand { }*. Until countermanded by some other randomization directive, all of these bracketed parameters may be randomly transformed, introduced, or eliminated in performance. As such, they provide an improvisational stimulus to the players while framing the artistic boundaries within which the music can evolve.

Related 'curly bracket notations' involving randomized parameters are:

+*Rand { }* – add these bracketed parameter(s) to the previous *Rand { }* directive;

–*Rand* { } – subtract these bracketed parameter(s) from the previous *Rand* { } directive;

End Rand { } – end the randomization of these bracketed parameter(s);

End Rand – end *all* randomization of technical/musical parameters: *Rand* { } is concluded.

Whenever *Rand* { } is in operation, any technical instructions notated between parentheses – () – take mandatory precedence, locally and temporarily overriding the randomization process. For instance, a sonority assigned the dynamic indication (*ppp*) during a passage when *Rand* {*p*→*mf*} is functional, *must* be played in *ppp*, irrespective of this particular *Rand* { } directive!

2. THE AMPLIFIED RECORDERS: DETAILS

AMPLIFICATION OF THE RECORDERS

In order for the recorders to achieve adequate acoustical projection and a proper balance with the other instruments in **Lines of Light: Seven Improvisations on αιθερος μελος**, some discreet sound-reinforcement of the recorders (with a high-quality cardioid or omnidirectional air microphone) will be necessary in concert – i.e. *all recorders must be amplified*! However, the level of amplification ought to be kept to a minimum, so that the recorders' natural timbres will be heard as clearly as possible: so, excessive sound-reinforcement is to be avoided. Optimally, the loudspeaker(s) for the recorders should be positioned near the recorder-player, so as to create the impression of a single sound-source for these instruments, thereby maintaining the integrity of the spatial distribution of sound as it corresponds to the placement of each performer on stage.

PREPARATION OF THE AMPLIFIED ALTO RECORDER, AND ITS 'FRACTALOUS' SONORITIES

On the "prepared" alto recorder (which is employed only within sections 1 and 2 of **Lines of Light: Seven Improvisations on αιθερος μελος**), it is imperative that the bore's endpoint, at the footjoint's endhole, be closed *absolutely airtight*. I recommend the adhesion of a flat lozenge of "Blutac", "Bostik", "Plasticine", or some other malleable gummy substance to the bell, covering over the endhole completely. Such a preparation modifies the timbral, dynamic, and intonational response of the instrument; pitches somewhat below the alto recorder's regular gamut can be generated as well.

For each of the prepared alto recorder's 'fractalous' sonorities in sections 1 and 2, all pitches between a pair of bold orthogonal brackets [] manifest themselves as distinct vibrational modes of a *single fingering*: hence, no finger-movement whatsoever should take place prior to progressing on to the next sonority! However, as a direct outcome of engaging the randomized parameters given within these sections, compel these orthogonally-bracketed pitches to 'crack' upwards or downwards, flickering chaotically between and through several vibrational modes and multiphonic component tones. The overall impression of these complex coruscative objects should therefore be one of *volatile instability* – a locally unpredictable 'acoustic fractal'.

All orthogonally-bracketed sets of prepared alto recorder pitches from sections 1 and 2 have been assigned a *ringed ordinal number*; the duration of these 'fractalous' pitch-sets within each bar is, however, left to the discretion of the recorder-player – subject only to the condition that each specified bar-length must be maintained.

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ARTICULATION

All articulation – *legato*, *tenuto*, *portato*, *mezzo staccato*, *staccato*, etc. – should be strictly observed. The following special recorder articulations are also utilized in **Lines of Light: Seven Improvisations on αιθερος μελος**:

∇ denotes *sputato* – a noisy, exaggerated, 'dirty' overblown attack.

ʈ denotes a compulsory *alveolar plosive attack*, utilizing the phoneme 't' (as in "tiger"), necessary to secure the multiphonic pitches.

ʰ denotes an *aspirated attack*, using the phoneme 'h' (as in "hamster"): the sonority is to be rendered *without any tonguing whatsoever*. When this articulation is underpinned by an accent, the aspiration is intensified so that it becomes a *diaphragm thrust*.

ʃ denotes *fluttersong*, a trilling of the tongue-tip against the alveolar ridge, or alternatively, a trilling of the back of the tongue against the uvula (soft palate) – as in gargling. Either type of fluttersong – alveolar or uvular – is acceptable throughout **Lines of Light**: the type, speed, and intensity of the fluttersong to be employed at each occurrence is left to the discretion of the recorder-player.

ʒ denotes a *tongue-tremolo*. Articulate, *as quickly and as evenly as possible*, the (double-tonguing) phonemes '[d]idl(d)idl(d)idl...' – as in "middle" – or the much more common (double-tonguing) pattern '[t]eketeke...' ('[d]egegede...'). The type and intensity of the tongue-tremolo to be employed at each occurrence throughout **Lines of Light** is left to the discretion of the recorder-player.

RECORDER FINGERINGS

Research of fingering-resources for **Lines of Light: Seven Improvisations on αιθερος μελος** was carried out upon an ebony Moeck Rottenburgh alto recorder (prepared as described above), an ebony Moeck Rottenburgh soprano recorder, and an ebony Moeck Rottenburgh keyless tenor recorder. Every fingering-indication provided within the recorder part of **Lines of Light** that *supplies the notated pitch(es) accurately over the given duration* is to be strictly adhered to: any modifications of such fingerings are forbidden! But whenever a recorder fingering yields an unacceptably inaccurate outcome, or is acoustically untenable on a particular instrument, then the performer is at liberty to alter that fingering – subject to the proviso that the resultant recorder sonority matches, as closely as possible *in context*, the composer's original intention. (If no such fingering exists, then just do your best with the provided fingering.) Note that sometimes one elicits a stipulated pitch from the given fingering 'by inflection' with the breath, purely through an appropriate boosting or attenuation of breath-pressure.

QUARTERTONES AND OTHER MICROTONES

♯ and ♭ denote a *quartertone above* ♮, and a *quartertone below* ♮, respectively (i.e. 24-tone equal temperament). Arrowheads upon any accidentals denote slight intonational deviations – up to about an eighthtone, but not necessarily tempered – in the given direction.

MULTIPHONICS

Multiphonic notation in **Lines of Light: Seven Improvisations on αιθερος μελος** is necessarily incomplete: sidebands, such as 'difference tones', are excluded. Nevertheless,

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the pitches of the highest and lowest multiphonic component tones are carefully notated and should therefore be fairly accurate in performance. If, however, any *infinitesimal* pitch-discrepancies do occur in playing these multiphonics on your recorders, then they can be ignored! Unless otherwise specified, dynamic levels are unambiguously defined by the breath-requirements necessary to generate multiphonics such that their pair of constituent tones are *equally balanced*. Aside from such well-balanced multiphonics, the following multiple sonorities also occur:

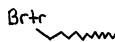


denotes an *octave multiphonic* or a 'split octave' (characterized notationally by a small open square above the stave). Using the normal fingering for the lowest (first-register) note of the notated octave, render its tone 'reedy' by augmenting the breath-pressure so that both octave pitches sound simultaneously, as part of a *rich, rattly, murky timbre* wherein the second partial is almost as strong as the fundamental. The presence of internal 'beating' or 'rattles' – caused by the mistuned octave – is indicated by the wavy vertical squiggle to the right of the noteheads.



denotes a recorder multiphonic *spectral portamento contour*. In direct correspondence with the curve, augment and diminish your breath-pressure so as to cause a continuous shifting in the dynamic levels of (and balance between) the multiphonic's audible component tones. Each point along the curve therefore displays the relative (im)balance between these multiphonic pitches.

OTHER RECORDER TECHNIQUES



denotes a *breath trill*, whose pitch-oscillations and -fluctuations are generated entirely through breath- and throat-control, without any finger-movement whatsoever! (The vibrational modes within a 'breath trill' are always fairly unstable, and so respond quite readily to small changes in breath-pressure.)



denotes a (descending) *breath portamento*. Without any alteration of fingering whatsoever, permit the given pitch to fall down indeterminately, as your breath-pressure diminishes to nothing.



denotes a *fingervibrato* together with *fingerslapping* (repeatedly slapping the indicated fingers down, as hard as possible, onto their fingerholes). Its fingering and trilling action are specified by the tablature pictograph below the stave, wherein each *x* signifies a slapping finger.

RANDOMIZED PARAMETERS WITHIN THE AMPLIFIED RECORDERS' PART

The randomized parameters, listed below in the order in which they appear within the amplified recorders' part, are:

Section 1

Randomize: {the (s)pacing of events (i.e. their speed and density); "breath trills", alternations between *fluttersong* and *tongue-tremolo*; normal articulations (e.g. *staccato*, *portato*, *legato*), air-flow such that the indicated tones may sound}

Section 2

Set 1 – Randomize: {alternations of the given fingerings; air-flow (such that the given pitches are elicited *mostly in legato*)}

Set 2 – Randomize: {alternations between *fluttersong* and *tongue-tremolo*}

Set 3 – +Rand {air-flow (such that the given pitches are elicited)}

Sets 4, 7, 11 & 12 – Randomize parameters exactly as in section 1

Sets 5 & 8 – End Rand

Set 6 – Randomize: {alternations between *fluttersong* and *tongue-tremolo*; air-flow (such that the given pitches are elicited, but *mostly stable*)}

Set 9 – Randomize: {"breath trills", *tongue-tremolo*, normal articulations (e.g. *staccato*, *portato*, *legato*), air-flow (such that the given pitches are elicited)}

Set 10 – +Rand {some *fluttersong*}

The final gesture of Section 2, arising out of Set 12 – End Rand

Sections 3 & 5

Tacet!

Sections 4 & 7

End Rand

Section 6

Randomize: {*ppp*↔*p* (dynamic levels ranging between *ppp* and *p*)}

3. THE YAMAHA DX7 KEYBOARD SYNTHESIZERS: DETAILS

ON THE NUMBER OF KEYBOARDISTS

The part in **Lines of Light: Seven Improvisations on αιθερος μελος** for two Yamaha DX7 keyboard synthesizers (DX7 I = a Series I or a Series II instrument; DX7 II = a Series II instrument) can be performed perfectly well by just one keyboardist. However, since this work does embrace spontaneity as a compositional dimension, an even richer sonic result – texturally, timbrally, and musically – will be obtained by employing *two* keyboardists, each of them playing upon only one Yamaha DX7 synthesizer. Except for sections 4 and 7 (where DX7 I and DX7 II are clearly assigned separate rôles), I have deliberately written this part upon just two staves without specifying which synthesizer or voice is to produce any given note; indeed, the DX7s' voices are often subjected to 'randomization'. So, regardless of the number of keyboardists who have been engaged to play **Lines of Light**, in sections 1, 2, 3 and 5, the precise deployment of each Yamaha DX7 synthesizer within this part is left entirely to the discretion of the performer(s).

DYNAMIC INDICATIONS, ARTICULATION AND DURATIONS

Note that all dynamic indications within this part refer only to *key-velocity*: a foot controller pedal ('volume pedal') connected to each Yamaha DX7 synthesizer regulates the global output volume for each keyboard. Similarly, all durations and articulations (from *staccatissimo* to *tenuto*) within this part merely define the time over which keys, or a foot switch pedal ('sustain pedal', for sustain on/off), are *depressed*, but not necessarily the duration of the sound itself – which may well be heard ringing on beyond the release of keys or sustain pedals.

THE YAMAHA DX7 SYNTHESIZERS' VOICES

All twelve Yamaha DX7 synthesizer voices that arise throughout **Lines of Light: Seven Improvisations on αιθερος μελος** were created by the composer; the parametric data for each of these voices is appended to these Performance Notes. I have also included a 'null voice' therein, for use on the Yamaha DX7 Series I [DX7 I]: in order to prevent any highly

undesirable ‘after-resonance’ on this synthesizer when executing a voice-change at the end of a section, do please switch to the ‘null voice’ first to eliminate all sound. (Such an action will not be necessary on the Yamaha DX7 Series II [DX7 II], upon which one can perform immediate, ‘clean’ voice-changes.)

The following table summarizes the dissemination of all twelve of my Yamaha DX7 synthesizer voices that I have employed throughout **Lines of Light**:

Section	Yamaha DX7 I (Series I or II) Voice(s)	Yamaha DX7 II (Series II) Voice(s)
1	"Bowed Crot"	"VibeSizzle"
2	Both DX7s: "Clay Pot", "Dabachi 2", "Dabachi 4", "Dabachi 6": a free choice among these, including various combinations of these voices (any or all); on the DX7 II, the application of its 'split-key' capability or its simultaneity of voices is permitted. (Alternatively, other voices from amongst my twelve original DX7 voices listed herein – such as "VibeSizzle" or "Bowed Crot" – may be selected, for the sake of timbral unity...)	
3	"Dabachi 3"	"Chimes 1"
4	"VibeSizzle"	'Split-key': "Dabachi 4" (C \sharp 1 – F \sharp 3) & "Dabachi 2" (G \flat 3 – C \sharp 6); or other voices...
5	"LowHollow1"	"Dabachi 5" (or other voices...)
6	Tacet!	Tacet!
7	"LowHollow2"	'Split-key': "Bowed Crot" (C \flat 1 – B \flat 3) & "Vibesizz" (C \flat 4 – C \flat 6) *
		* NB: "Vibesizz" <u>is</u> distinct from "VibeSizzle"!

RANDOMIZED PARAMETERS WITHIN THE YAMAHA DX7 KEYBOARD SYNTHESIZERS' PART

The randomized parameters, listed below in the order in which they appear within the Yamaha DX7 keyboard synthesizers' part, are:

Section 1

Randomize: {voice (i.e. the choice of keyboard), (multi)octave transpositions, the addition of unspecified material, the (s)pacing of events (i.e. their speed and density); textures (e.g. single tones, chords, grace-note groups, arpeggiation, tremoli...) – *including tremolandi (ca.40% of the time)*; durations of key-depression, the depression and release of the sustaining pedal; key-velocities (*ppp*↔*fff*) – *these last three parameters interacting so that the sound-level never rises above 'mp'*}

Section 2

Randomize: {the selection of DX7 voices, (multi)octave transpositions; durations of key-depression, the depression and release of the sustaining pedal; key-velocities (*ppp*↔*ff*)}

Section 3

Randomize: {voice (i.e. the choice of keyboard) – *but biased somewhat towards DX7 II*, (multi)octave transpositions, *the addition of unspecified material*, the (s)pacing of events (i.e. their speed and density); textures (e.g. single tones, chords, grace-note groups, arpeggiation, tremoli...), durations of key-depression, the depression and release of the sustaining pedal; key-velocities (*ppp*↔*f*)}

–Rand {the addition of unspecified material}

+Rand {the addition of unspecified material}

Section 4

- DX7 I – End Rand
- DX7 II – Randomize: {(multi)octave transpositions; the addition of unspecified material and/or the deletion of given material, the (s)pacing of events (i.e. their speed and density); textures (e.g. single tones, chords, grace-note groups, arpeggiation, tremoli...); durations of key-depression, the depression and release of the sustaining pedal}
- DX7 II – *Optional*: End Rand {the addition of unspecified material}

Section 5

- Randomize: {voice (i.e. the choice of keyboard), (multi)octave transpositions, the addition of unspecified material and/or the deletion of given material; the (s)pacing of events (i.e. their speed and density); textures (e.g. single tones, chords, grace-note groups, arpeggiation, tremoli...); *manipulations of the pitch-wheel (maximum range up = maximum range down = one semitone)*; durations of key-depression, the depression and release of the sustaining pedal; key-velocities (*ppp*↔*fff*)}
- Optional*: Randomize {the pressing down and lifting up of the volume pedals}
- End Rand {(multi)octave transpositions}
- DX7 II – Beautiful and interesting results may be obtained by experimenting with this keyboard's *microtonal* capabilities – through the activation, transformation, and neutralization of any of the Yamaha DX7 Series II's microtonal keyboard settings (i.e. equal-tempered microtones, or unequal [historical] temperaments)...

Section 6

Tacet!

Section 7



End Rand

4. THE METALLIC PERCUSSION INSTRUMENTS: DETAILS

ON THE NUMBER OF PERCUSSIONISTS

The part in **Lines of Light: Seven Improvisations on αιθερος μελος** for metallic percussion instruments can be performed perfectly well by just a single percussionist. However, since this piece does embrace spontaneity as a compositional dimension, an even richer sonic result – texturally, timbrally, and musically – will be obtained by employing *two* percussionists. In this situation, I entrust the disentangling of the percussion part (i.e. the apportionment of the percussion instruments between the two players) to the percussionists themselves, who will then need to modify the given instrumental layout accordingly.

ARTICULATION

-  denotes a 'deadstick'. Once the mallet has struck a sound-producer of a percussion instrument, it remains in physical contact with the strike-point, without rebounding, thereby muffling or damping any after-resonance. The resultant sound's envelope will thus be a fairly brief 'choked' staccato.
-  denotes *damping* a sound-producer of a percussion instrument – by hand, or with a mallet – *to silence* after it has been struck. The precise shape of the sound's envelope will therefore depend upon the time elapsed between striking thence damping the sound-producer: throughout **Lines of Light**, this musical factor is left entirely to the discretion of the percussionist(s).

GLISSANDI ON THE TUBULAR BELLS

Throughout **Lines of Light: Seven Improvisations on αιθερος μελος**, all *glissandi* carried out on the set of tubular bells take place only upon those tubes corresponding to the diatonic ('natural') notes – sweeping either downwards from F \sharp 4, or upwards from C \flat 3. Neither the initial (parenthesized) pitch nor the final pitch of such glissandi should be accentuated or individually attacked; moreover, these final pitches are never actually specified, so that all glissando ranges herein are open-ended. Most glissandi on the tubular bells should, however, traverse at least an octave or thereabouts, as implied by their graphic notation. Although governed by the prevailing dynamic indications, the exact *speed of execution* of each glissando across the tubular bells is left to the discretion of the executant.

VIBRAPHONE VIBRATO

Rates of vibrato on the vibraphone are specified by *ringed numbers*: ① indicates *non-vibrato* (i.e. 'motor off'); ⑥ signifies the vibraphone's maximum vibrato-frequency; ① and ② ≈ 'slow' vibrati; ③ and ④ ≈ 'medium' vibrati; and ⑤ ≈ a 'fast' vibrato. Between the extremes of ① and ⑥, the numbers ①, ②, ③, ④, and ⑤ denote *approximately* equal gradations of vibrato-rate; hence, each of these numbers is perhaps best thought of as a narrow *bandwidth* of vibrato-frequencies, so that ③ (for example) does not designate a precise, fixed rate of vibrato for each of its occurrences.

When the vibraphone's motor is *turned off* (i.e. to ①: non-vibrato) before beginning section 6, do please remember also to rotate the vibrato-discs at the top of the instrument's resonators to their vertical position – in order to capture the vibraphone's maximum degree of sonorousness throughout section 6.

Smooth transitions between numbered rates of vibrato (i.e. *vibrato accelerandi* or *vibrato rallentandi*) are depicted by appropriately sloping *dashed lines* which connect the ring around one vibrato number to that around the next.

It is most probably advantageous to employ an assistant whose sole purpose will be to manipulate the vibraphone's potentiometer, and thus regulate its rate of vibrato.

MALLETS

The following pictographs illustrate the different types of percussion mallet called for throughout **Lines of Light: Seven Improvisations on αιθερος μελος**. Drawn together in various combinations, such pictographs show the number, type, and deployment between the left and right hands of mallets required over each section of the music. Usage of the 'plus' and 'minus' symbols (+, –) in this context indicates a straightforward change from the basic mallet-configuration.

In relation to certain metallic percussion instruments (such as the autocoil and the Chinese bell tree), a mallet pictograph marked "sempre" means that throughout the given section, only the indicated mallet-type should be used to elicit sound from this instrument.



denotes a soft vibraphone mallet.



denotes a yarn-wound vibraphone mallet of medium hardness.



denotes a very hard plastic or heavy brass glockenspiel mallet.



denotes a high-quality wound leather hammer for the tubular bells.



denotes a 'composite hammer' for the tubular bells: i.e. a normal leather hammer (as described above), plus some sort of heavy metal mallet for striking the tubes front-on (below their caps). The heavy metal mallet may be held separately in the hand, or instead, it can be attached to the leather hammer somehow; alternatively, a hard metal washer or coin could be adhered to one end of the leather hammer!



denotes an authentic hard wooden rin beater (*absolutely not* the soft, suede- or kidskin-bound variety); such beaters usually accompany the rin themselves. This quite rare type of beater resembles a short wooden rod, about 150 mm long, wrapped lightly with thin colourful cloth: if it is unavailable, then substitute an ordinary hard wooden or hard plastic mallet instead.

PERCUSSION INSTRUMENTS: DETAILED DESCRIPTIONS AND ABBREVIATIONS

Within the percussion part from **Lines of Light: Seven Improvisations on αιθερος μελος**, all of the metallic percussion instruments are notated *in sequential order according to their physical distribution*; they are listed below in the same fashion.

Tubular Bells: Tub Bells

Range: C \sharp 3 — F \sharp 4. A high-quality (chromatic) set of tubular bells is required. Note that **Lines of Light: Seven Improvisations on αιθερος μελος** does not call for any pedalling of the tubular bells whatsoever: just lock the instrument's sustaining pedal down fully (or instead secure it with a brick or cinder block) for the entire duration of the piece, thereby allowing all tubular bells to resonate freely – ringing on indefinitely after being struck.

7 Japanese Temple Bells (Rin): Rin

Seven small- to medium-sized Japanese 'cup bells' (rin), resting upon their traditional cushions, which radiate extremely beautiful, resonant, sparkling, microtonal bell-sounds – all of them exhibiting very long decay-times. The seven rin utilized for the world première performance of **Lines of Light: Seven Improvisations on αιθερος μελος** were pitched as follows: **1** – B \flat 4; **2** – A \sharp 4; **3** – A \flat 4; **4** – G \flat 4; **5** – D \flat 4; **6** – B \flat 3; **7** – G \sharp 3. These particular micro-intonations within my set of seven rin here were very much in my 'mind's ear' throughout the composition of **Lines of Light**; it is, therefore, highly desirable (if not obligatory) that instruments which conform as closely as possible to these tunings be procured!

Chinese Bell Tree: CBT

A nested set of microtonal bells, strung together on a rod in order of size. Upward and downward glissandi – as well as their relative speeds and approximate starting positions – are notated graphically, as usual.

Large Autocoil: Coil

A large helical spring, from the front-end suspension of a car, hung up high by a leather bootlace. An arrow to the left of a notehead indicates a sweeping rasp-like 'arpeggiando' attack (either upwards or downwards) that dramatically runs along the whole length of the helix, striking most (or all) loops in rapid succession; otherwise, for the coil's normal mode of performance, tap just a single loop.

'Triangle Windchime': △WC*

Three triangles of different size/pitch – i.e. small, medium, and large triangles – grouped together (as a windchime) in such a way that each triangle bangs against the others without losing much of its natural resonance.

2 (or more) Brass Tube Windchimes: Metal Tube WC *

1 – About twenty or so medium to small thick brass tubes (outer diameter ca.6-10 mm, maximum length ca.330 mm), sounding within the range F#4 — C#7: brilliant, starry, cutting, high-pitched; ca.15" decay.

2 – About ten or so large brass tubes (outer diameter ca.18-25 mm, maximum length ca.610 mm), sounding approximately within the range E#3 — A#4: brilliant, cutting, rather like small tubular bells; ca.20" decay.

Note that within **Lines of Light: Seven Improvisations on αιθερος μελος**, these brass-tube windchimes are played just once, in section 2!

Crotales: Crot

Written range: C#3 — C#4, sounding two octaves higher than notated. The thirteen crotali should be rack-mounted, in the manner of a keyboard.

Vibraphone: Vib

Range: F#2 — F#5. A high-quality modern instrument (with wide bars in its low register) is required. The vibraphone must also be equipped with an electric motor and potentiometer that will yield a continuously variable speed of vibrato – widely ranging from 'slow' to 'fast'; a vibrato on/off capability, activated either by a switch or by the potentiometer, is needed as well.

NB: although it is suggested merely as an option, it could well prove beneficial to engage in performance an assistant to manipulate the vibraphone's potentiometer.

* Windchimes

Agitate the elements of these windchimes directly, with hand(s) or mallet(s), roughly in accord with the notated waveform contours. All windchime attacks and excitations should be varied as much as possible, subject to the indicated dynamic levels (if any).

RANDOMIZED PARAMETERS WITHIN THE PERCUSSION PART

The randomized parameters, listed below in the order in which they appear within the percussion part, are:

Section 1

Randomize: {the addition of unspecified material, the (s)pacing of events (i.e. their speed and density); textures (e.g. single tones, chords, grace-note groups, arpeggiation, tremoli...) – including tremolandi (ca.40% of the time); $ppp \leftrightarrow mp$ (dynamic levels ranging between ppp and mp); 'deadsticking' and damping-to-silence – both less than 10% of the time}

Vibraphone – Randomize: {the rate of vibrato within the range ②↔⑤; the release of the sustaining pedal less than 10% of the time – so, very resonant}

Section 2

Randomize: {the durations between successive notes (up to a maximum duration of approximately three seconds); 'deadsticking', damping-to-silence, the depression and release of the vibraphone's sustaining pedal; $ppp \leftrightarrow fff$ (dynamic levels ranging between ppp and fff)}

Section 3

Tubular Bells – Randomize: {the addition of unspecified material, the (s)pacing of events (i.e. their speed and density); textures (e.g. single tones, chords, grace-note groups, arpeggiation, tremoli...); alternations between striking the tubular bells with wound-leather hammer(s) and striking the tubular bells with heavy metal mallet(s) (using the 'composite hammers'); 'deadsticking' and damping-to-silence – both less than 25% of the time; $ppp \leftrightarrow fff$ (dynamic levels covering the full range between ppp and fff)}

Section 4

Randomize: {the addition of unspecified material and/or the deletion of given material, the (s)pacing of events (i.e. their speed and density); textures (e.g. single tones, chords, grace-note groups, arpeggiation, tremoli...); $ppp \leftrightarrow fff$ (dynamic levels ranging between ppp and fff)}

Crotales – Randomize: {'deadsticking' and damping-to-silence – both less than 25% of the time}

Vibraphone – Randomize: {the rate of vibrato within the range ①↔⑥ – but only one motor-setting per bar}

Section 5

Tacet!

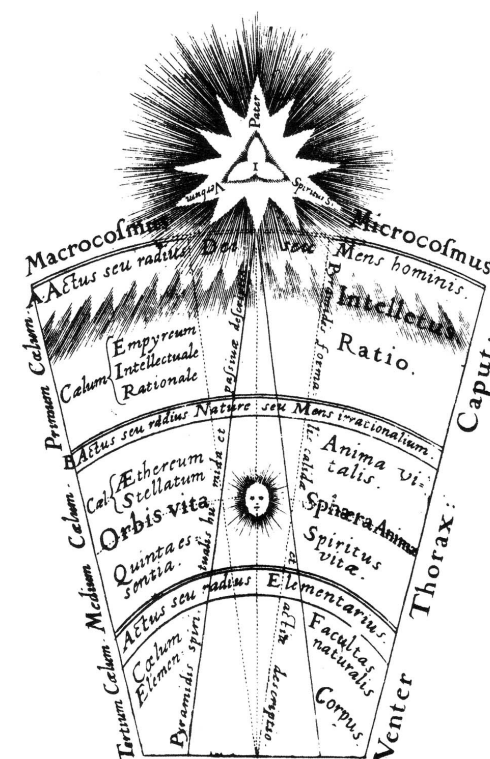
Section 6

Randomize: { $ppp \leftrightarrow p$ (dynamic levels ranging between ppp and p)}

Section 7

End Rand

© Ian Shanahan, Sydney, Australia; 3 November 1993;
slightly revised 9 May 2005.



VOICE DATA for the Yamaha DX7 Keyboard Synthesizers

VOICE NAME: *Bowed Crot*

Created by: Ian Shanahan

Sections that require this voice in "Lines of Light"

DX7 I: 1, 2 (possibly)

DX7 II: 2 (possibly), 7

Algorithm: 05

Feedback: 1

Key Transpose: C2

Pitch Modulation Sensitivity: 1

Oscillator Synchronization: On

LFO: Wave

Speed

Delay

PMD

AMD

Sync

Triangle

20

91

08

00

On

	Operator 1	Operator 2	Operator 3	Operator 4	Operator 5	Operator 6
Ampl. Mod. Sens.:	0	0	0	0	0	0
Mode:	Ratio	Ratio	Ratio	Ratio	Ratio	Ratio
Frequency:	02.00	13.00	02.00	13.00	02.00	13.00
Detune:	+3	-3	+0	+1	-7	+7
EG Rate 1:	39	76	39	75	39	74
EG Rate 2:	31	20	32	22	39	28
EG Rate 3:	13	14	15	15	47	30
EG Rate 4:	33	19	32	18	37	39
EG Level 1:	99	99	99	99	99	99
EG Level 2:	73	63	75	67	72	66
EG Level 3:	00	00	00	00	00	00
EG Level 4:	00	00	00	00	00	00
Keyboard Level Scaling						
Break Pt.:	A-1	A-1	A-1	A-1	A-1	A-1
Curve L:	-LIN	-LIN	-LIN	-LIN	-LIN	-LIN
Curve R:	-LIN	-LIN	-LIN	-LIN	-LIN	-LIN
Depth L:	00	00	00	00	00	00
Depth R:	00	00	00	00	00	00
Kbd. Rate Scaling:	0	2	0	2	1	3
Op. Outpt. Level:	99	99	99	99	99	99
K. Velocity Sens.:	4	2	4	2	7	5
Pitch EG						
Rate 1: 99	Level 1: 50					
Rate 2: 99	Level 2: 50					
Rate 3: 99	Level 3: 50					
Rate 4: 99	Level 4: 50					

Poly/Mono: Poly

Pitch Bend:

Range

Step

01

00

Portamento:

Mode

Glissando

Time

Sus-Key P Retain

Off

00

Modulation Wheel:

Range

Pitch

Amplitude

EG Bias

00

Off

Off

Off

Foot Control:

00

Off

Off

Off

Breath Control:

00

Off

Off

Off

Aftertouch:

00

Off

Off

Off

VOICE NAME: *VibeSizzle*

Created by: Ian Shanahan

Sections that require this voice in “Lines of Light”

DX7 I: 2 (possibly), 4
DX7 II: 1, 2 (possibly)

Algorithm: 29

Feedback: 3

Key Transpose: A1

Pitch Modulation Sensitivity: 1

Oscillator Synchronization: On

LFO: Wave	Speed	Delay	PMD	AMD	Sync
Sine	14	99	13	12	On

	Operator 1	Operator 2	Operator 3	Operator 4	Operator 5	Operator 6
Ampl. Mod. Sens.:	0	0	0	1	0	0
Mode:	Ratio	Ratio	Ratio	Ratio	Ratio	Ratio
Frequency:	04.71	04.71	02.00	13.00	02.00	13.00
Detune:	+3	-2	-3	+0	+3	-4
EG Rate 1:	58	61	18	79	39	83
EG Rate 2:	00	38	22	16	22	13
EG Rate 3:	21	19	27	15	28	14
EG Rate 4:	27	28	29	21	29	20
EG Level 1:	99	99	94	99	99	99
EG Level 2:	99	86	67	81	67	82
EG Level 3:	00	00	00	00	00	00
EG Level 4:	00	00	00	00	00	00

Keyboard Level Scaling

Break Pt.:	A-1	A-1	A-1	A-1	A-1	A-1
Curve L:	-LIN	-LIN	-LIN	-LIN	-LIN	-LIN
Curve R:	-LIN	-LIN	-LIN	-LIN	-LIN	-LIN
Depth L:	00	00	00	00	00	00
Depth R:	00	00	00	00	00	00
Kbd. Rate Scaling:	2	0	0	4	0	4
Op. Outpt. Level:	99	99	80	99	79	99
K. Velocity Sens.:	4	4	4	1	4	1

Pitch EG

Rate 1: 99	Level 1: 50
Rate 2: 99	Level 2: 50
Rate 3: 99	Level 3: 50
Rate 4: 99	Level 4: 50

Poly/Mono: Poly

Pitch Bend:	Range	Step
	01	00

Portamento:	Mode	Glissando	Time
	Sus-Key P Retain	Off	00

	Range	Pitch	Amplitude	EG Bias
Modulation Wheel:	00	Off	Off	Off
Foot Control:	00	Off	Off	Off
Breath Control:	00	Off	Off	Off
Aftertouch:	00	Off	Off	Off

VOICE NAME: *Clay Pot*

Created by: Ian Shanahan

Sections that require this voice in “Lines of Light”

DX7 I: 2 (either DX7)
DX7 II: 2 (either DX7)

Algorithm: 05

Feedback: 0

Key Transpose: E3

Pitch Modulation Sensitivity: 1

Oscillator Synchronization: On

LFO: Wave	Speed	Delay	PMD	AMD	Sync
Triangle	19	47	16	00	On

	Operator 1	Operator 2	Operator 3	Operator 4	Operator 5	Operator 6
Ampl. Mod. Sens.:	0	0	0	0	0	0
Mode:	Ratio	Ratio	Ratio	Ratio	Ratio	Ratio
Frequency:	01.57	04.2	01.57	04.23	01.57	04.23
Detune:	-5	+5	+3	-3	-2	+1
EG Rate 1:	81	85	79	84	83	80
EG Rate 2:	51	47	50	46	45	51
EG Rate 3:	35	36	34	35	36	33
EG Rate 4:	43	35	42	34	41	26
EG Level 1:	99	99	99	99	99	99
EG Level 2:	75	71	74	72	73	75
EG Level 3:	00	00	00	00	00	00
EG Level 4:	00	00	00	00	00	00

Keyboard Level Scaling

Break Pt.:	A-1	A-1	A-1	A-1	A-1	A-1
Curve L:	-LIN	-LIN	-LIN	-LIN	-LIN	-LIN
Curve R:	-LIN	-LIN	-LIN	-LIN	-LIN	-LIN
Depth L:	00	00	00	00	00	00
Depth R:	00	00	00	00	00	00
Kbd. Rate Scaling:	0	0	0	0	0	0
Op. Outpt. Level:	99	71	99	70	99	70
K. Velocity Sens.:	4	4	4	4	4	4

Pitch EG

Rate 1: 99	Level 1: 50
Rate 2: 99	Level 2: 50
Rate 3: 99	Level 3: 50
Rate 4: 99	Level 4: 50

Poly/Mono: Poly

Pitch Bend:	Range	Step
	01	00

Portamento:	Mode	Glissando	Time
	Sus-Key P Retain	Off	00

	Range	Pitch	Amplitude	EG Bias
Modulation Wheel:	00	Off	Off	Off
Foot Control:	00	Off	Off	Off
Breath Control:	00	Off	Off	Off
Aftertouch:	00	Off	Off	Off

VOICE NAME: *Dabachi 2*

Created by: Ian Shanahan

Sections that require this voice in “Lines of Light”

DX7 I: 2 (either DX7)
DX7 II: 2 (either DX7), 4

Algorithm: 29

Feedback: 5

Key Transpose: C3

Pitch Modulation Sensitivity: 1

Oscillator Synchronization: On

LFO: Wave	Speed	Delay	PMD	AMD	Sync
Sine	21	54	17	00	On

	Operator 1	Operator 2	Operator 3	Operator 4	Operator 5	Operator 6
Ampl. Mod. Sens.:	0	0	0	0	0	0
Mode:	Ratio	Ratio	Ratio	Ratio	Ratio	Ratio
Frequency:	02.00	03.14	02.00	03.46	02.00	03.46
Detune:	-1	+0	+4	-6	+2	-1
EG Rate 1:	86	61	77	80	77	80
EG Rate 2:	00	48	00	00	00	00
EG Rate 3:	39	41	40	36	40	36
EG Rate 4:	41	43	42	35	42	35
EG Level 1:	99	99	99	99	99	99
EG Level 2:	99	86	99	99	99	99
EG Level 3:	00	00	00	00	00	00
EG Level 4:	00	00	00	00	00	00

Keyboard Level Scaling

Break Pt.:	A-1	A-1	A-1	A-1	A-1	A-1
Curve L:	-LIN	-LIN	-LIN	-LIN	-LIN	-LIN
Curve R:	-LIN	-LIN	-LIN	-LIN	-LIN	-LIN
Depth L:	00	00	00	00	00	00
Depth R:	00	00	00	00	00	00
Kbd. Rate Scaling:	0	0	0	0	0	0
Op. Outpt. Level:	99	87	99	70	99	70
K. Velocity Sens.:	4	4	4	4	4	4

Pitch EG

Rate 1: 99	Level 1: 50
Rate 2: 99	Level 2: 50
Rate 3: 99	Level 3: 50
Rate 4: 99	Level 4: 50

Poly/Mono: Poly

Pitch Bend:	Range	Step
	01	00

Portamento:	Mode	Glissando	Time
	Sus-Key P Retain	Off	00

	Range	Pitch	Amplitude	EG Bias
Modulation Wheel:	00	Off	Off	Off
Foot Control:	00	Off	Off	Off
Breath Control:	00	Off	Off	Off
Aftertouch:	00	Off	Off	Off

VOICE NAME: *Dabachi 4*

Created by: Ian Shanahan

Sections that require this voice in “Lines of Light”

DX7 I: 2 (either DX7)
DX7 II: 2 (either DX7), 4

Algorithm: 05

Feedback: 4

Key Transpose: C3

Pitch Modulation Sensitivity: 1

Oscillator Synchronization: On

LFO: Wave	Speed	Delay	PMD	AMD	Sync
Sine	08	81	25	00	On

	Operator 1	Operator 2	Operator 3	Operator 4	Operator 5	Operator 6
Ampl. Mod. Sens.:	0	0	0	0	0	0
Mode:	Ratio	Ratio	Ratio	Ratio	Ratio	Ratio
Frequency:	02.0	03.14	02.00	03.14	02.00	03.14
Detune:	+0	-5	-2	+1	+3	-3
EG Rate 1:	32	40	66	67	67	70
EG Rate 2:	23	19	22	21	23	19
EG Rate 3:	28	28	25	32	28	28
EG Rate 4:	30	13	17	33	30	13
EG Level 1:	99	99	99	99	99	99
EG Level 2:	86	87	68	88	86	87
EG Level 3:	00	00	00	00	00	00
EG Level 4:	00	00	00	00	00	00

Keyboard Level Scaling

Break Pt.:	A-1	A-1	A-1	A-1	A-1	A-1
Curve L:	-LIN	-LIN	-LIN	-LIN	-LIN	-LIN
Curve R:	-LIN	-LIN	-LIN	-LIN	-LIN	-LIN
Depth L:	00	00	00	00	00	00
Depth R:	00	00	00	00	00	00
Kbd. Rate Scaling:	4	4	7	4	4	4
Op. Outpt. Level:	90	76	99	77	99	78
K. Velocity Sens.:	7	7	4	4	4	4

Pitch EG

Rate 1: 99	Level 1: 50
Rate 2: 99	Level 2: 50
Rate 3: 99	Level 3: 50
Rate 4: 99	Level 4: 50

Poly/Mono: Poly

Pitch Bend:	Range	Step
	01	00

Portamento:	Mode	Glissando	Time
	Sus-Key P Retain	Off	00

	Range	Pitch	Amplitude	EG Bias
Modulation Wheel:	00	Off	Off	Off
Foot Control:	00	Off	Off	Off
Breath Control:	00	Off	Off	Off
Aftertouch:	00	Off	Off	Off

VOICE NAME: *Dabachi 6*

Created by: Ian Shanahan

Sections that require this voice in “Lines of Light”

DX7 I: 2 (either DX7)
DX7 II: 2 (either DX7)

Algorithm: 32

Feedback: 4

Key Transpose: C3

Pitch Modulation Sensitivity: 1

Oscillator Synchronization: On

LFO: Wave	Speed	Delay	PMD	AMD	Sync
Triangle	25	73	18	00	On

	Operator 1	Operator 2	Operator 3	Operator 4	Operator 5	Operator 6
Ampl. Mod. Sens.:	0	0	0	0	0	0
Mode:	Ratio	Ratio	Ratio	Ratio	Ratio	Ratio
Frequency:	03.14	03.46	03.14	03.46	02.00	02.00
Detune:	+3	+1	-2	-1	-3	+2
EG Rate 1:	73	80	73	80	70	77
EG Rate 2:	43	38	43	38	42	45
EG Rate 3:	32	29	32	29	42	39
EG Rate 4:	42	41	42	41	43	44
EG Level 1:	99	99	99	99	99	99
EG Level 2:	92	93	92	93	87	86
EG Level 3:	00	00	00	00	00	00
EG Level 4:	00	00	00	00	00	00

Keyboard Level Scaling

Break Pt.:	A-1	A-1	A-1	A-1	A-1	A-1
Curve L:	-LIN	-LIN	-LIN	-LIN	-LIN	-LIN
Curve R:	-LIN	-LIN	-LIN	-LIN	-LIN	-LIN
Depth L:	00	00	00	00	00	00
Depth R:	00	00	00	00	00	00
Kbd. Rate Scaling:	0	0	0	0	0	0
Op. Outpt. Level:	99	87	99	88	99	99
K. Velocity Sens.:	4	4	4	4	4	4

Pitch EG

Rate 1: 99	Level 1: 50
Rate 2: 99	Level 2: 50
Rate 3: 99	Level 3: 50
Rate 4: 99	Level 4: 50

Poly/Mono: Poly

Pitch Bend:	Range	Step
	01	00

Portamento:	Mode	Glissando	Time
	Sus-Key P Retain	Off	00

	Range	Pitch	Amplitude	EG Bias
Modulation Wheel:	00	Off	Off	Off
Foot Control:	00	Off	Off	Off
Breath Control:	00	Off	Off	Off
Aftertouch:	00	Off	Off	Off

~ xxi ~

VOICE NAME: *Dabachi 3*

Created by: Ian Shanahan

Sections that require this voice in “Lines of Light”

DX7 I: 3
DX7 II: -

Algorithm: 32

Feedback: 2

Key Transpose: C1

Pitch Modulation Sensitivity: 1

Oscillator Synchronization: On

LFO: Wave	Speed	Delay	PMD	AMD	Sync
Sine	10	87	24	00	On

	Operator 1	Operator 2	Operator 3	Operator 4	Operator 5	Operator 6
Ampl. Mod. Sens.:	0	0	0	0	0	0
Mode:	Ratio	Ratio	Ratio	Ratio	Ratio	Ratio
Frequency:	04.00	04.00	09.87	09.87	09.87	04.00
Detune:	+0	-7	+0	+2	-1	+4
EG Rate 1:	72	77	77	73	75	75
EG Rate 2:	28	30	28	30	29	29
EG Rate 3:	34	31	33	30	32	32
EG Rate 4:	42	38	40	38	39	39
EG Level 1:	99	99	99	99	99	99
EG Level 2:	70	70	70	70	70	70
EG Level 3:	00	00	00	00	00	00
EG Level 4:	00	00	00	00	00	00

Keyboard Level Scaling

Break Pt.:	A-1	A-1	A-1	A-1	A-1	A-1
Curve L:	-LIN	-LIN	-LIN	-LIN	-LIN	-LIN
Curve R:	-LIN	-LIN	-LIN	-LIN	-LIN	-LIN
Depth L:	00	00	00	00	00	00
Depth R:	00	00	00	00	00	00
Kbd. Rate Scaling:	4	4	2	2	2	4
Op. Outpt. Level:	99	99	99	99	99	99
K. Velocity Sens.:	4	7	4	4	7	4

Pitch EG

Rate 1: 99	Level 1: 50
Rate 2: 99	Level 2: 50
Rate 3: 99	Level 3: 50
Rate 4: 99	Level 4: 50

Poly/Mono: Poly

Pitch Bend:	Range	Step
	01	00

Portamento:	Mode	Glissando	Time
	Sus-Key P Retain	Off	00

	Range	Pitch	Amplitude	EG Bias
Modulation Wheel:	00	Off	Off	Off
Foot Control:	00	Off	Off	Off
Breath Control:	00	Off	Off	Off
Aftertouch:	00	Off	Off	Off

~ xxii ~

VOICE NAME: *Chimes 1*

Created by: Ian Shanahan

Sections that require this voice in “Lines of Light”

DX7 I: –
DX7 II: 3

Algorithm: 29

Feedback: 2

Key Transpose: G# 1

Pitch Modulation Sensitivity: 1

Oscillator Synchronization: On

LFO: Wave	Speed	Delay	PMD	AMD	Sync
Triangle	11	82	10	99	Off

	Operator 1	Operator 2	Operator 3	Operator 4	Operator 5	Operator 6
Ampl. Mod. Sens.:	0	3	0	0	0	0
Mode:	Ratio	Ratio	Ratio	Ratio	Ratio	Ratio
Frequency:	02.50	02.50	07.00	02.82	07.00	02.82
Detune:	–5	–1	–3	+4	–5	+2
EG Rate 1:	58	54	86	78	86	78
EG Rate 2:	00	07	37	26	27	26
EG Rate 3:	21	19	41	35	26	35
EG Rate 4:	27	28	43	19	40	19
EG Level 1:	99	99	99	99	99	99
EG Level 2:	99	92	64	67	64	67
EG Level 3:	00	00	00	00	00	00
EG Level 4:	00	00	00	00	00	00

Keyboard Level Scaling

Break Pt.:	A–1	A–1	A–1	A–1	A–1	A–1
Curve L:	–LIN	–LIN	–LIN	–LIN	–LIN	–LIN
Curve R:	–LIN	–LIN	–LIN	–LIN	–LIN	–LIN
Depth L:	00	00	00	00	00	00
Depth R:	00	00	00	00	00	00
Kbd. Rate Scaling:	2	2	2	4	2	4
Op. Outpt. Level:	99	99	99	81	99	81
K. Velocity Sens.:	4	4	4	4	4	4

Pitch EG

Rate 1: 99	Level 1: 50
Rate 2: 99	Level 2: 50
Rate 3: 99	Level 3: 50
Rate 4: 99	Level 4: 50

Poly/Mono: Poly

Pitch Bend:	Range	Step
	01	00

Portamento:	Mode	Glissando	Time
	Sus-Key P Retain	Off	00

	Range	Pitch	Amplitude	EG Bias
Modulation Wheel:	00	Off	Off	Off
Foot Control:	00	Off	Off	Off
Breath Control:	00	Off	Off	Off
Aftertouch:	00	Off	Off	Off

VOICE NAME: *LowHollow1*

Created by: Ian Shanahan

Sections that require this voice in “Lines of Light”

DX7 I: 5
DX7 II: –

Algorithm: 05

Feedback: 0

Key Transpose: E2

Pitch Modulation Sensitivity: 1

Oscillator Synchronization: On

LFO: Wave	Speed	Delay	PMD	AMD	Sync
Triangle	06	73	19	00	On

	Operator 1	Operator 2	Operator 3	Operator 4	Operator 5	Operator 6
Ampl. Mod. Sens.:	0	0	0	0	0	0
Mode:	Ratio	Ratio	Ratio	Ratio	Ratio	Ratio
Frequency:	00.78	05.00	00.78	05.00	00.78	05.00
Detune:	+3	–1	–4	+5	–2	+2
EG Rate 1:	76	79	75	78	72	80
EG Rate 2:	28	31	25	29	23	32
EG Rate 3:	29	15	31	14	28	13
EG Rate 4:	34	17	36	18	35	16
EG Level 1:	99	99	99	99	99	99
EG Level 2:	83	85	82	83	81	86
EG Level 3:	00	00	00	00	00	00
EG Level 4:	00	00	00	00	00	00

Keyboard Level Scaling

Break Pt.:	A–1	A–1	A–1	A–1	A–1	A–1
Curve L:	–LIN	–LIN	–LIN	–LIN	–LIN	–LIN
Curve R:	–LIN	–LIN	–LIN	–LIN	–LIN	–LIN
Depth L:	00	00	00	00	00	00
Depth R:	00	00	00	00	00	00
Kbd. Rate Scaling:	0	0	0	0	0	0
Op. Outpt. Level:	99	86	99	85	99	84
K. Velocity Sens.:	4	4	4	4	4	4

Pitch EG

Rate 1: 99	Level 1: 50
Rate 2: 99	Level 2: 50
Rate 3: 99	Level 3: 50
Rate 4: 99	Level 4: 50

Poly/Mono: Poly

Pitch Bend:	Range	Step
	01	00

Portamento:	Mode	Glissando	Time
	Sus-Key P Retain	Off	00

	Range	Pitch	Amplitude	EG Bias
Modulation Wheel:	00	Off	Off	Off
Foot Control:	00	Off	Off	Off
Breath Control:	00	Off	Off	Off
Aftertouch:	00	Off	Off	Off

VOICE NAME: *Dabachi 5*

Created by: Ian Shanahan

Sections that require this voice in “Lines of Light”

DX7 I: –
DX7 II: 5

Algorithm: 31

Feedback: 4

Key Transpose: C2

Pitch Modulation Sensitivity: 1

Oscillator Synchronization: On

LFO: Wave	Speed	Delay	PMD	AMD	Sync
Triangle	19	91	18	00	On

	Operator 1	Operator 2	Operator 3	Operator 4	Operator 5	Operator 6
Ampl. Mod. Sens.:	0	0	0	0	0	0
Mode:	Ratio	Ratio	Ratio	Ratio	Ratio	Ratio
Frequency:	01.73	01.73	04.00	04.00	03.00	04.71
Detune:	–3	+7	+3	–6	+3	–2
EG Rate 1:	45	20	58	58	78	77
EG Rate 2:	40	46	00	65	31	32
EG Rate 3:	36	50	26	32	29	28
EG Rate 4:	42	42	30	36	31	30
EG Level 1:	99	68	99	99	99	99
EG Level 2:	67	40	99	72	68	69
EG Level 3:	00	00	00	00	00	00
EG Level 4:	00	00	00	00	00	00

Keyboard Level Scaling

Break Pt.:	A–1	A–1	A–1	A–1	A–1	A–1
Curve L:	–LIN	–LIN	–LIN	–LIN	–LIN	–LIN
Curve R:	–LIN	–LIN	–LIN	–LIN	–LIN	–LIN
Depth L:	00	00	00	00	00	00
Depth R:	00	00	00	00	00	00
Kbd. Rate Scaling:	0	0	2	2	4	4
Op. Outpt. Level:	93	84	92	92	99	78
K. Velocity Sens.:	4	2	4	3	4	4

Pitch EG

Rate 1: 99	Level 1: 50
Rate 2: 99	Level 2: 50
Rate 3: 99	Level 3: 50
Rate 4: 99	Level 4: 50

Poly/Mono: Poly

Pitch Bend:	Range	Step
	01	00

Portamento:	Mode	Glissando	Time
	Sus-Key P Retain	Off	00

	Range	Pitch	Amplitude	EG Bias
Modulation Wheel:	00	Off	Off	Off
Foot Control:	00	Off	Off	Off
Breath Control:	00	Off	Off	Off
Aftertouch:	00	Off	Off	Off

VOICE NAME: *LowHollow2*

Created by: Ian Shanahan

Sections that require this voice in “Lines of Light”

DX7 I: 7
DX7 II: –

Algorithm: 05

Feedback: 2

Key Transpose: D1

Pitch Modulation Sensitivity: 1

Oscillator Synchronization: On

LFO: Wave	Speed	Delay	PMD	AMD	Sync
Triangle	15	88	10	00	On

	Operator 1	Operator 2	Operator 3	Operator 4	Operator 5	Operator 6
Ampl. Mod. Sens.:	0	0	0	0	0	0
Mode:	Ratio	Ratio	Ratio	Ratio	Ratio	Ratio
Frequency:	00.86	05.00	00.86	05.00	00.86	05.00
Detune:	+1	+7	–2	+2	+2	–1
EG Rate 1:	58	76	59	79	57	74
EG Rate 2:	39	15	33	13	38	00
EG Rate 3:	20	20	15	21	19	19
EG Rate 4:	30	22	26	27	34	17
EG Level 1:	99	99	99	99	99	99
EG Level 2:	88	95	94	92	86	99
EG Level 3:	00	00	00	00	00	00
EG Level 4:	00	00	00	00	00	00

Keyboard Level Scaling

Break Pt.:	A–1	A–1	A–1	A–1	A–1	A–1
Curve L:	–LIN	–LIN	–LIN	–LIN	–LIN	–LIN
Curve R:	–LIN	–LIN	–LIN	–LIN	–LIN	–LIN
Depth L:	00	00	00	00	00	00
Depth R:	00	00	00	00	00	00
Kbd. Rate Scaling:	0	2	0	2	0	2
Op. Outpt. Level:	98	83	97	85	99	84
K. Velocity Sens.:	4	3	4	3	4	3

Pitch EG

Rate 1: 99	Level 1: 50
Rate 2: 99	Level 2: 50
Rate 3: 99	Level 3: 50
Rate 4: 99	Level 4: 50

Poly/Mono: Poly

Pitch Bend:	Range	Step
	01	00

Portamento:	Mode	Glissando	Time
	Sus-Key P Retain	Off	00

	Range	Pitch	Amplitude	EG Bias
Modulation Wheel:	00	Off	Off	Off
Foot Control:	00	Off	Off	Off
Breath Control:	00	Off	Off	Off
Aftertouch:	00	Off	Off	Off

VOICE NAME: *Vibesizz*

Created by: Ian Shanahan

Sections that require this voice in “Lines of Light”

DX7 I: –
DX7 II: 7

Algorithm: 29

Feedback: 3

Key Transpose: A1

Pitch Modulation Sensitivity: 1

Oscillator Synchronization: On

LFO: Wave	Speed	Delay	PMD	AMD	Sync
Sine	14	99	13	12	On

	Operator 1	Operator 2	Operator 3	Operator 4	Operator 5	Operator 6
Ampl. Mod. Sens.:	0	0	0	1	0	0
Mode:	Ratio	Ratio	Ratio	Ratio	Ratio	Ratio
Frequency:	02.36	02.36	01.00	06.50	01.00	06.50
Detune:	+3	–2	–3	+0	+3	–4
EG Rate 1:	58	61	18	79	39	83
EG Rate 2:	00	38	22	16	22	13
EG Rate 3:	21	19	27	15	28	14
EG Rate 4:	27	28	29	21	29	20
EG Level 1:	99	99	94	99	99	99
EG Level 2:	99	86	67	81	67	82
EG Level 3:	00	00	00	00	00	00
EG Level 4:	00	00	00	00	00	00

Keyboard Level Scaling

Break Pt.:	A–1	A–1	A–1	A–1	A–1	A–1
Curve L:	–LIN	–LIN	–LIN	–LIN	–LIN	–LIN
Curve R:	–LIN	–LIN	–LIN	–LIN	–LIN	–LIN
Depth L:	00	00	00	00	00	00
Depth R:	00	00	00	00	00	00
Kbd. Rate Scaling:	2	0	0	4	0	4
Op. Outpt. Level:	99	99	80	99	79	99
K. Velocity Sens.:	4	4	4	1	4	1

Pitch EG

Rate 1: 99	Level 1: 50
Rate 2: 99	Level 2: 50
Rate 3: 99	Level 3: 50
Rate 4: 99	Level 4: 50

Poly/Mono: Poly

Pitch Bend:	Range	Step
	01	00

Portamento:	Mode	Glissando	Time
	Sus-Key P Retain	Off	00

	Range	Pitch	Amplitude	EG Bias
Modulation Wheel:	00	Off	Off	Off
Foot Control:	00	Off	Off	Off
Breath Control:	00	Off	Off	Off
Aftertouch:	00	Off	Off	Off

VOICE NAME: *null*

Created by: Yamaha Corporation?

For use on the DX7 Series I only: use the null voice between every voice-change.

Algorithm: 01

Feedback: 0

Key Transpose: C3

Pitch Modulation Sensitivity: 0

Oscillator Synchronization: Off

LFO: Wave	Speed	Delay	PMD	AMD	Sync
Triangle	00	00	00	00	Off

	Operator 1	Operator 2	Operator 3	Operator 4	Operator 5	Operator 6
Ampl. Mod. Sens.:	0	0	0	0	0	0
Mode:	Ratio	Ratio	Ratio	Ratio	Ratio	Ratio
Frequency:	01.00	01.00	01.00	01.00	01.00	01.00
Detune:	+0	+0	+0	+0	+0	+0
EG Rate 1:	99	99	99	99	99	99
EG Rate 2:	99	99	99	99	99	99
EG Rate 3:	99	99	99	99	99	99
EG Rate 4:	99	99	99	99	99	99
EG Level 1:	00	00	00	00	00	00
EG Level 2:	00	00	00	00	00	00
EG Level 3:	00	00	00	00	00	00
EG Level 4:	00	00	00	00	00	00

Keyboard Level Scaling

Break Pt.:	A–1	A–1	A–1	A–1	A–1	A–1
Curve L:	–LIN	–LIN	–LIN	–LIN	–LIN	–LIN
Curve R:	–LIN	–LIN	–LIN	–LIN	–LIN	–LIN
Depth L:	00	00	00	00	00	00
Depth R:	00	00	00	00	00	00
Kbd. Rate Scaling:	0	0	0	0	0	0
Op. Outpt. Level:	00	00	00	00	00	00
K. Velocity Sens.:	0	0	0	0	0	0

Pitch EG

Rate 1: 99	Level 1: 50
Rate 2: 99	Level 2: 50
Rate 3: 99	Level 3: 50
Rate 4: 99	Level 4: 50

Poly/Mono: Poly

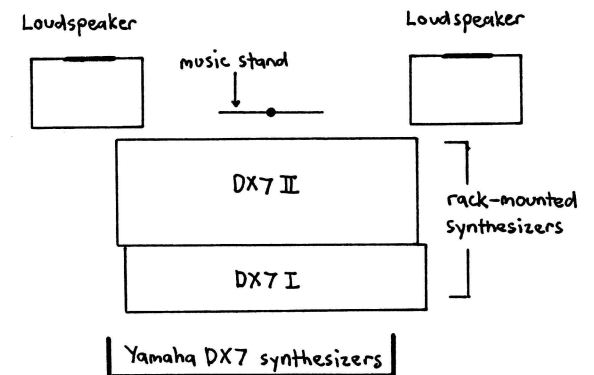
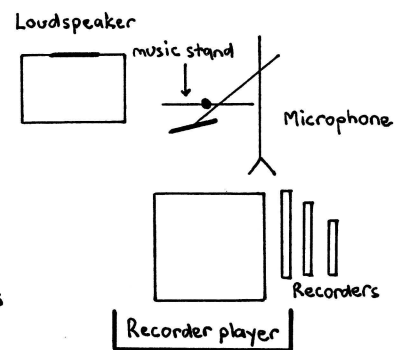
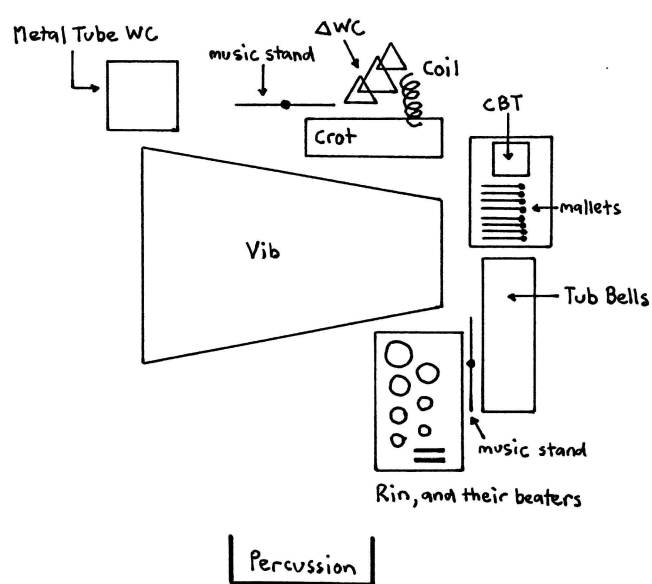
Pitch Bend:	Range	Step
	00	00

Portamento:	Mode	Glissando	Time
	Sus-Key P Retain	Off	00

	Range	Pitch	Amplitude	EG Bias
Modulation Wheel:	00	Off	Off	Off
Foot Control:	00	Off	Off	Off
Breath Control:	00	Off	Off	Off
Aftertouch:	00	Off	Off	Off

AUDIENCE

PHYSICAL LAYOUT OF THE INSTRUMENTS



Lines of Light

Seven Improvisations on αἰθέρος μέλος

© Ian Shanahan, Sydney, AUSTRALIA; 3 November 1993

- In Memoriam Barbara Burke.
- For Roger Dean and Daryl Pratt to play with me.

Lines of Light

*Seven Improvisations
on αιθερος μελος*

Improvisation 1

A volcanic yet ephemeral texture: glittering unceasingly, with great luminosity and searing heat (bubbling lava, solar flares, core of the sun...). Maintain intensity of activity throughout. Breathe furtively: minimize caesurae (except where indicated).



1.1 RECORDER

1


A volcanic yet ephemeral texture: glittering unceasingly, with great luminosity and searing heat (bubbling lava, solar flares, core of the sun...).
 Maintain intensity of activity throughout, adding your own material accordingly.

Voices:


DX7 I - Bowed Crot
 DX7 II - Vibesizzle

Rand { voice, octave transpositions, add material, (s) pacing of events; texture — , , etc. — including tremolandi ($\approx 40\%$); $\bullet \longleftrightarrow \bullet$ (length of key-depression), pedal; $ppp \longleftrightarrow fff$ (key velocity), these last three parameters interacting so that the sound-level almost never rises above 'mp' }

DX7s



DX7s



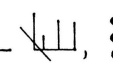

DX7s



allow sounds to decay naturally;
 go straight on...

1

A volcanic yet ephemeral texture: glittering unceasingly, with great luminosity and searing heat (bubbling lava, solar flares, core of the sun...).
Maintain intensity of activity throughout, adding your own material accordingly.

↓ Rand {add material, (s) pacing of events; texture - , etc. - including tremolandi (≈ 40%); ppp ↔ mp;  ≤ 10%}

5+ 34

Rin/ Tub Bells Rin Tub Bells gliss. Ped (h) always down

CBT Coil

ΔWC

Crot 15

Vib

Vib: Rand {motor ② ↔ ⑤; pedal up ≤ 10% - so, very resonant}

Ped

13½ 20½

Rin/ Tub Bells Rin Tub Bells gliss. Rin

CBT Coil

ΔWC

Crot 15

Vib

play the C4 if possible!

Handwritten musical score for Percussion, measures 18 to 22.

Measures 18-22:

- Rin/Tub Bells:**
 - Measure 18: Rin (18 $\frac{1}{4}$), notes 5, 6, 1, 2.
 - Measure 19: Tub Bells (gliss.), Rin (1, 2).
 - Measure 20: Tub Bells (gliss.), Rin (5, 3, 2, 6).
 - Measure 21: Tub Bells (gliss.), Rin (7, 4, 1).
 - Measure 22: Rin (4, 1).
- CBT Coil:** Notes 5, 6, 1, 2, 5, 3, 2, 6, 7, 4, 1.
- Δ WC:** Notes 15, 15, 15, 15, 15, 15, 15, 15, 15, 15, 15, 15.
- Crot:** Notes 15, 15, 15, 15, 15, 15, 15, 15, 15, 15, 15, 15.
- Vib:** Notes 15, 15, 15, 15, 15, 15, 15, 15, 15, 15, 15, 15.

Handwritten musical score for Percussion, measures 11 to 18.

Measures 11-18:

- Rin/Tub Bells:**
 - Measure 11: Rin (11 $\frac{1}{4}$), notes 1, 4.
 - Measure 12: Tub Bells (gliss.), Rin (6, 2, 1, 3).
 - Measure 13: Tub Bells (gliss.), Rin (4, 5, 7).
 - Measure 14: Rin (4, 5, 7).
 - Measure 15: Rin (4, 5, 7).
 - Measure 16: Rin (4, 5, 7).
 - Measure 17: Rin (4, 5, 7).
 - Measure 18: Rin (4, 5, 7).
- CBT Coil:** Notes 1, 4, 6, 2, 1, 3, 4, 5, 7, 4, 5, 7, 4, 5, 7, 4, 5, 7.
- Δ WC:** Notes 15, 15, 15, 15, 15, 15, 15, 15, 15, 15, 15, 15.
- Crot:** Notes 15, 15, 15, 15, 15, 15, 15, 15, 15, 15, 15, 15.
- Vib:** Notes 15, 15, 15, 15, 15, 15, 15, 15, 15, 15, 15, 15.

allow sounds to decay naturally;
go straight on...

Improvisation 2

Handwritten musical score for a single melodic line, likely for a flute or recorder, featuring various rhythmic patterns, articulations, and dynamic markings. The score is divided into three systems, each with a key signature of one sharp (F#) and a time signature of 4/4.

System 1:

- Measures 1-4: Labeled "Rand {alternations of fingering; air-flow}" and "Rand {air-flow...}". Includes a "Prep. A. Rec." marking.
- Measures 5-8: Labeled "Rand as in 1".
- Measures 9-12: Labeled "End Rand".

System 2:

- Measures 13-16: Labeled "Rand {breath trills", normal articulations, air-flow}" and "Rand {some}". Includes a "Prep. A. Rec." marking.
- Measures 17-20: Labeled "End Rand".


System 3:

- Measures 21-24: Labeled "Rand as in 1".
- Measures 25-28: Labeled "End Rand".

The score includes various musical notations such as notes, rests, slurs, and articulation marks. It also features handwritten annotations like "Brtr (irregular)" and "optional!".

Prep.
A. Rec.

Take Soprano Recorder for 4



BRIEF, COORDINATED INTERJECTIONS: Place interjection ① within the first 'real' silence (after the recorder's 5th sonority). Choose three or four more boxes from among the remaining menu of interjections - reach agreement on this during rehearsal - and deploy them freely, wherever desired, thereafter. (Do try to overlap them with the recorder's indeterminate silences somewhat.)

DX7s: Rand {voice, octave transpositions; $\bullet \leftrightarrow \bar{\bullet}$ (length of key-depression), pedal; ppp \leftrightarrow ff (key velocity)}

Percussion: Rand { durations $\leq \approx 3''$; \ast , \bullet , \bullet , vibraphone pedalling; ppp \leftrightarrow fff }

Voices:

Clay Pot, Dabachi 2, } free choice among these - various combinations (any/all); key split; simultaneity...
Dabachi 4, Dabachi 6 } or other voices - e.g. Vibesizzle, Bowed Crot - may be selected, for timbral unity...

①

DX7s

CBT coil

Metal Tube WC

Crot

Vib

②

as fast as possible

③

play the C4 if possible!

④

⑤

as fast as possible

⑥ ⑦ ⑧

DX7s

CBT
Coil

Metal Tube WC

15




Crot

Vib

Commence the next section as soon as the recorder has finished - no caesura.

Improvisation 3

A complex interplay of photons : brilliant, expansive and volatile.

DX7s: Rand { voice - but biased somewhat towards DX7 II, octave transpositions, add material, (s) pacing of events; texture -  ,  etc.;  (length of key depression), pedal; ppp → f (key velocity) }

Voices:
DX7 I - Dabachi 3
DX7 II - Chimes 1

DX7s

18 4

Tubular Bells: Rand { add material, (s) pacing of events; texture -  , etc.;  ;  ≤ 25%; ppp → f }

gliss.

Ped (h -)

always down

7 4

DX7s

11

- Rand { add material }

(Ped — ...)

9 4

+ Rand { add material }

11 wild and cosmic.

turn hammer sideways.

9 4

DX7s

11 $\frac{3}{4}$ dissipating...

Tub Bells

11 $\frac{3}{4}$ dissipating...

6

Ped

Rin

DX7s

9 $\frac{3}{4}$

DX7 I: End Rand

pause briefly before going on...

do not damp!

Rin

1 3 2 6 5 4 7

(m) f ↔ ff...

Improvisation 4

A fresh onslaught: like all-embracing waves of light!

DX7 I

S.Rec.

all multiphonics: well-balanced.

Voces:
DX7 I - VibeSizzle
DX7 II - Dabachi 4 / Dabachi 2 (or other voices)

Rec

DX7 II: Rand { octave transpositions; add/delete material, (s) pacing of events; texture - [vertical lines], [dots], etc.; ; ↔ • }
(length of key-depression), pedal }

DX7 I

sffz

Ped sffz

"echo"

p poss. sempre!

DX7 II

Rin

CBT Coil

ΔWC

Crot

Vib

Ped

Percussion: Rand { add/delete material, (s) pacing of events; texture - [vertical lines], [dots], ↑, etc.; }
ppp → fff ?

sempre

6 2 1 4

sempre

5

sempre

Crot: Rand { * , ≤ 25% }

Vib: Rand { motor ① ↔ ⑥ - but only one motor-setting per bar }

(pp)

[illegible]



Handwritten musical score for a multi-instrument ensemble. The score is divided into three measures by vertical bar lines. The instruments listed on the left are: S. Rec., DX7 I, DX7 II, Rin, CBT Coil, ΔWC, Crot, and Vib. The S. Rec. part includes a melodic line with notes and rests, and a series of circles below it. The DX7 I and DX7 II parts are mostly empty. The Rin, CBT Coil, and ΔWC parts are also empty. The Crot part has a note marked (ppp). The Vib part has a note marked (mp). A Pedal line is at the bottom, with markings (mp) and (mf) and a long line indicating the pedal is depressed. A thick vertical bar line is placed at the end of the third measure, with the text 'commence the next section immediately...' written to its right. Above the S. Rec. staff, there is a box containing '7 1/4' and the text 'Take Tenor Recorder for [6]'. Below the Vib staff, there is a box containing '4.3'.

Take Tenor Recorder for [6]

commence the next section immediately...

Improvisation 5

Free and spacious — cosmic.

Rand { voice, octave transpositions, add/delete material, (s) pacing of events; texture — , etc.; pitch-wheel (max. range = 1 semitone);  (length of key-depression), pedal; ppp → fff (key velocity) } Optional: Rand { volume pedals }

DX7 II: beautiful and interesting results may be obtained by experimenting with this keyboard's microtonal capabilities...

Voices:

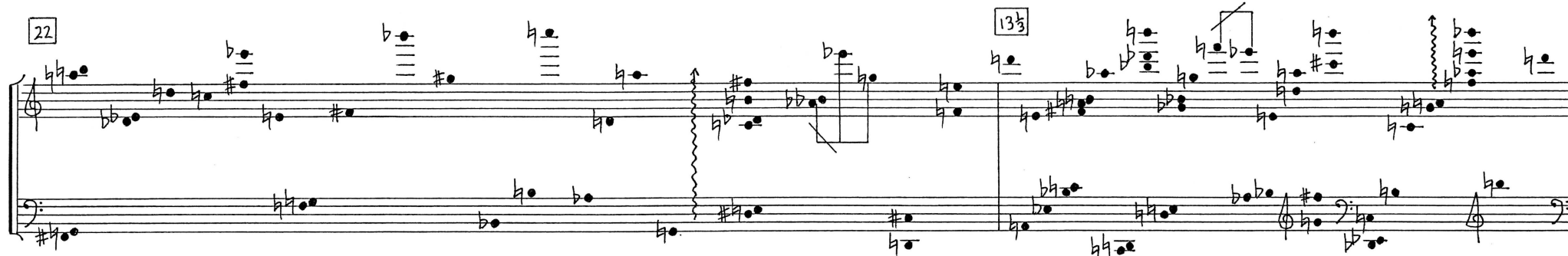
DX7 I — Low Hollow 1

DX7 II — Dabachi 5 (or other voices)

DX7s

22

13 3/4



DX7s

11 3/4

8 3/4

14 3/4



DX7s

7 1/4

12

End Rand { octave transpositions }

brilliant, piercing.

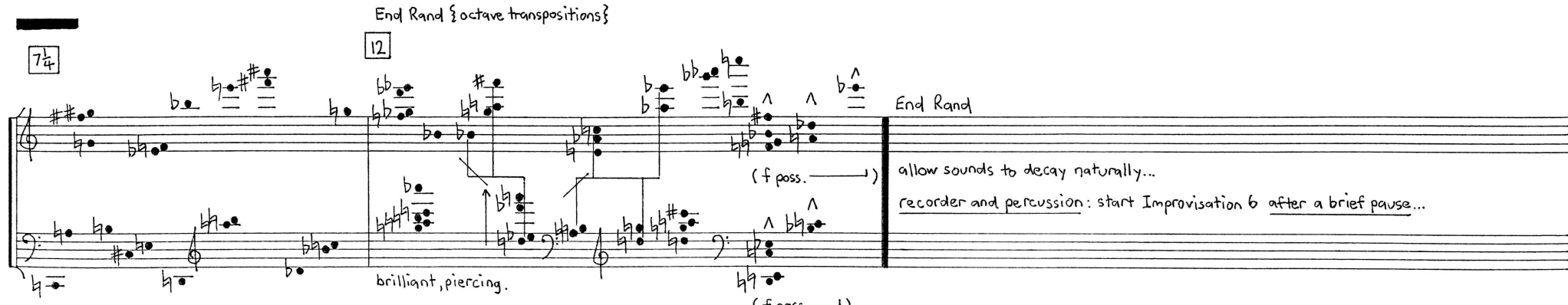
(f poss. —)

End Rand

allow sounds to decay naturally...

recorder and percussion: start Improvisation 6 after a brief pause...

(f poss. —)



Improvisation 6

6

Infinitely placid, timeless.

Recorder: Rand { ppp ↔ p } No breath-vibrato: absolutely steady!

11 4 0 1 2 3 4 5 6 7 8 9 Crot 10 11 6 0 1 2

1 ≈ 1 second exactly.

T. Rec. # full-bodied sound (p) N

11 4 Percussion: Rand { ppp ↔ p }

15 0 1 2 3 4 5 6 7 8 9 10 11 6 0 1 2

Crot

Vib

Ped

(ppp)

2 3 4 5 6 10 1 2 Crot 3 4 6 3 4 0 1 2 3 4 5

4 1 2 3 4 5 6 4 1 2 3 4 5

T. Rec. #

Crot

Vib

Ped

(p)

Handwritten musical score for three staves: T. Rec., Crot., and Vib. The score is divided into measures by vertical lines. Above the staves, there are handwritten numbers 5, 6, 0, 1, 2, 3, 4, 5, 6, 7, 0, 1, 2, 3. Above the first measure of T. Rec., there is a boxed number 7 1/4. Above the first measure of Crot., there is a boxed number 15. Above the first measure of Vib., there is a boxed number 15. The T. Rec. staff has a treble clef and a key signature of one sharp (F#). The Crot. staff has a treble clef and a key signature of one sharp (F#). The Vib. staff has a treble clef and a key signature of one sharp (F#). The T. Rec. staff has a series of dots in the first measure, and a series of dots in the second measure. The Crot. staff has a series of dots in the first measure, and a series of dots in the second measure. The Vib. staff has a series of dots in the first measure, and a series of dots in the second measure. A Pedal (Ped) line is written below the Vib. staff, with an arrow pointing to the right.

Handwritten musical score for three staves: T. Rec., Crot., and Vib. The score is divided into measures by vertical lines. Above the staves, there are handwritten numbers 0, 1, 2, 3, 4, 5, 6. Above the first measure of T. Rec., there is a boxed number 6. Above the first measure of Crot., there is a boxed number 6. Above the first measure of Vib., there is a boxed number 6. The T. Rec. staff has a treble clef and a key signature of one sharp (F#). The Crot. staff has a treble clef and a key signature of one sharp (F#). The Vib. staff has a treble clef and a key signature of one sharp (F#). The T. Rec. staff has a series of dots in the first measure, and a series of dots in the second measure. The Crot. staff has a series of dots in the first measure, and a series of dots in the second measure. The Vib. staff has a series of dots in the first measure, and a series of dots in the second measure. A Pedal (Ped) line is written below the Vib. staff, with an arrow pointing to the right. The text "distant, hollow" is written above the T. Rec. staff in the second measure. The text "(p)" is written below the T. Rec. staff in the second measure. The text "(p poss.)" is written below the T. Rec. staff in the third measure. The text "pause until all resonances decay almost to inaudibility, then go straight on..." is written above the T. Rec. staff in the fourth measure. The text "End Rand" is written to the right of the T. Rec. staff in the fourth measure. The text "End Rand" is written to the right of the Crot. staff in the fourth measure. The text "pause until all resonances decay almost to inaudibility, then go straight on..." is written above the Crot. staff in the fourth measure. The text "End Rand" is written to the right of the Crot. staff in the fourth measure. The text "pause until all resonances decay almost to inaudibility, then go straight on..." is written above the Vib. staff in the fourth measure. The text "End Rand" is written to the right of the Vib. staff in the fourth measure. The text "(pp)" is written below the Crot. staff in the fourth measure. The text "(ppp)" is written below the Vib. staff in the fourth measure.

Improvisation 7

αιθερος μελος : μελος φωτος

Monolithic but glistening: hieratic. "Music of the Spheres"

DX7 Voices:
DX7 I - Low Hollow 2
DX7 II - Bowed Crot/Vibesizz

★ Brilliant! Execute the flourish as fast and as violently as possible.

The musical score is written for DX7 voices and percussion. It consists of five staves, each with a 6/4 time signature and measures 0 through 6. The staves are labeled on the left: T.Rec., DX7 I, DX7 II, Rin/Tub Bells, and Vib. The T.Rec. staff includes notes with 'no breath-vibrato...' and 'steady...' markings, and a 'p poss. (zmp)' marking. The DX7 I and II staves include notes with 'f poss.', 'ff', 'p', 'mf', and 'f' markings, and a 'Ped' marking. The Rin/Tub Bells staff includes notes with 'sempre' and 'f' markings. The Vib staff includes notes with 'f poss.', 'ff', 'sfz', and 'mf' markings, and a 'Ped' marking. The score is annotated with various performance instructions and dynamic markings.

T.Rec.

DX7 I

DX7 II

Rin/
Tub Bells

Vib

all multiphonics:
well-balanced.

no breath-vibrato...

steady...

Fvbr

p poss. (zmp)

f poss.

ff

p

mf

f

sempre

sfz

mf

Ped

5

3

6

★ Brilliant! Execute the flourish as fast and as violently as possible.

Handwritten musical score for a multi-instrument ensemble. The score is divided into three systems, each with five measures. The instruments are listed on the left: T. Rec., DX7 I, DX7 II, Rin/ Tub Bells, CBT coil, Δwc, Crot, and Vib. The score includes various musical notations such as notes, rests, dynamics (mp, ff, f, mf, sffz), and performance instructions.

System 1 (Measures 1-5):

- T. Rec.:** Measure 1 has a boxed $5\frac{1}{2}$ and a downward arrow. Measures 2-5 show various notes and rests.
- DX7 I:** Measure 1 has a boxed $5\frac{1}{2}$ and a downward arrow. Measures 2-5 show various notes and rests.
- DX7 II:** Measure 1 has a boxed $5\frac{1}{2}$ and a downward arrow. Measures 2-5 show various notes and rests.
- Rin/ Tub Bells:** Measure 1 has a boxed $5\frac{1}{2}$ and a downward arrow. Measures 2-5 show various notes and rests.
- CBT coil:** Measure 1 has a boxed $5\frac{1}{2}$ and a downward arrow. Measures 2-5 show various notes and rests.
- Δwc:** Measure 1 has a boxed $5\frac{1}{2}$ and a downward arrow. Measures 2-5 show various notes and rests.
- Crot:** Measure 1 has a boxed $5\frac{1}{2}$ and a downward arrow. Measures 2-5 show various notes and rests.
- Vib:** Measure 1 has a boxed $5\frac{1}{2}$ and a downward arrow. Measures 2-5 show various notes and rests.

System 2 (Measures 6-10):

- T. Rec.:** Measure 6 has a boxed $3\frac{3}{4}$ and a downward arrow. Measures 7-10 show various notes and rests.
- DX7 I:** Measure 6 has a boxed $3\frac{3}{4}$ and a downward arrow. Measures 7-10 show various notes and rests.
- DX7 II:** Measure 6 has a boxed $3\frac{3}{4}$ and a downward arrow. Measures 7-10 show various notes and rests.
- Rin/ Tub Bells:** Measure 6 has a boxed $3\frac{3}{4}$ and a downward arrow. Measures 7-10 show various notes and rests.
- CBT coil:** Measure 6 has a boxed $3\frac{3}{4}$ and a downward arrow. Measures 7-10 show various notes and rests.
- Δwc:** Measure 6 has a boxed $3\frac{3}{4}$ and a downward arrow. Measures 7-10 show various notes and rests.
- Crot:** Measure 6 has a boxed $3\frac{3}{4}$ and a downward arrow. Measures 7-10 show various notes and rests.
- Vib:** Measure 6 has a boxed $3\frac{3}{4}$ and a downward arrow. Measures 7-10 show various notes and rests.

System 3 (Measures 11-15):

- T. Rec.:** Measure 11 has a boxed $3\frac{3}{4}$ and a downward arrow. Measures 12-15 show various notes and rests.
- DX7 I:** Measure 11 has a boxed $3\frac{3}{4}$ and a downward arrow. Measures 12-15 show various notes and rests.
- DX7 II:** Measure 11 has a boxed $3\frac{3}{4}$ and a downward arrow. Measures 12-15 show various notes and rests.
- Rin/ Tub Bells:** Measure 11 has a boxed $3\frac{3}{4}$ and a downward arrow. Measures 12-15 show various notes and rests.
- CBT coil:** Measure 11 has a boxed $3\frac{3}{4}$ and a downward arrow. Measures 12-15 show various notes and rests.
- Δwc:** Measure 11 has a boxed $3\frac{3}{4}$ and a downward arrow. Measures 12-15 show various notes and rests.
- Crot:** Measure 11 has a boxed $3\frac{3}{4}$ and a downward arrow. Measures 12-15 show various notes and rests.
- Vib:** Measure 11 has a boxed $3\frac{3}{4}$ and a downward arrow. Measures 12-15 show various notes and rests.

Annotations and Diagrams:

- right-hand finger closes the endhole:** A diagram showing a finger closing an endhole.
- endhole open:** A diagram showing an open endhole.
- ★ Brilliant! Execute the flourish as fast and as violently as possible.** (Repeated at the top of the page)
- ②** and **⑤** are circled numbers indicating specific measures or sections.
- ①** is a circled number at the end of the score.

Handwritten musical score for a multi-instrument ensemble, featuring measures 10 through 17. The score is divided into two systems, each containing seven staves.

Staff 1 (T.Rec.): Treble clef. Measures 10-16 show melodic lines with various accidentals (flats, naturals, sharps) and dynamics (mf, pp). Measure 17 continues the melodic line. A box labeled $6\frac{1}{3}$ is present above measure 10, and a box labeled $15\frac{1}{3}$ is present above measure 17.

Staff 2 (DX7 I): Treble clef. Measures 10-16 show melodic lines with various accidentals and dynamics (pp, p, mf, sffz). Measure 17 continues the melodic line. A box labeled $6\frac{1}{3}$ is present above measure 10, and a box labeled $15\frac{1}{3}$ is present above measure 17.

Staff 3 (DX7 II): Treble clef. Measures 10-16 show melodic lines with various accidentals and dynamics (f poss., p, mf, sffz). Measure 17 continues the melodic line. A box labeled $6\frac{1}{3}$ is present above measure 10, and a box labeled $15\frac{1}{3}$ is present above measure 17.

Staff 4 (Rin/ Tub Bells): Treble clef. Measures 10-16 show melodic lines with various accidentals and dynamics (pp, non cresc., ppp!). Measure 17 continues the melodic line. A box labeled $6\frac{1}{3}$ is present above measure 10, and a box labeled $15\frac{1}{3}$ is present above measure 17.

Staff 5 (CBT coil): Treble clef. Measures 10-16 show melodic lines with various accidentals and dynamics (pp, non cresc., ppp!). Measure 17 continues the melodic line. A box labeled $6\frac{1}{3}$ is present above measure 10, and a box labeled $15\frac{1}{3}$ is present above measure 17.

Staff 6 (Crot): Treble clef. Measures 10-16 show melodic lines with various accidentals and dynamics (pp, non cresc., ppp!). Measure 17 continues the melodic line. A box labeled $6\frac{1}{3}$ is present above measure 10, and a box labeled $15\frac{1}{3}$ is present above measure 17.

Staff 7 (Vib): Treble clef. Measures 10-16 show melodic lines with various accidentals and dynamics (f poss., sffz, mf). Measure 17 continues the melodic line. A box labeled $6\frac{1}{3}$ is present above measure 10, and a box labeled $15\frac{1}{3}$ is present above measure 17.

Staff 8 (Ped): Treble clef. Measures 10-16 show melodic lines with various accidentals and dynamics (f poss., sffz, mf). Measure 17 continues the melodic line. A box labeled $6\frac{1}{3}$ is present above measure 10, and a box labeled $15\frac{1}{3}$ is present above measure 17.

Handwritten musical score for a multi-instrument ensemble, spanning measures 7 to 15 and then 0 to 5. The instruments and their parts are:

- T. Rec.** (Trumpet): Measures 7-15 show a melodic line with notes and rests. Measure 10 includes a "Fvbr" marking and a "steady..." instruction. Measure 15 has a dynamic marking of "(mp)". Measures 0-5 show a melodic line with notes and rests, including a "solo: tender, plaintive and poignant..." instruction.
- DX7 I** (Digital Synthesizer): Measures 7-15 show a melodic line with notes and rests. Measure 10 includes a "P" marking. Measure 15 has a dynamic marking of "f poss.". Measures 0-5 show a melodic line with notes and rests, including a "f poss." marking.
- DX7 II** (Digital Synthesizer): Measures 7-15 show a melodic line with notes and rests. Measure 10 includes a "P" marking. Measure 15 has a dynamic marking of "f poss.". Measures 0-5 show a melodic line with notes and rests, including a "f poss." marking.
- Rin/ Tub Bells**: Measures 7-15 show a melodic line with notes and rests. Measure 10 includes a "P" marking. Measure 15 has a dynamic marking of "f poss.". Measures 0-5 show a melodic line with notes and rests, including a "f poss." marking.
- CBT coil**: Measures 7-15 show a melodic line with notes and rests. Measure 10 includes a "P" marking. Measure 15 has a dynamic marking of "f poss.". Measures 0-5 show a melodic line with notes and rests, including a "f poss." marking.
- ΔWC**: Measures 7-15 show a melodic line with notes and rests. Measure 10 includes a "P" marking. Measure 15 has a dynamic marking of "f poss.". Measures 0-5 show a melodic line with notes and rests, including a "f poss." marking.
- Crot**: Measures 7-15 show a melodic line with notes and rests. Measure 10 includes a "P" marking. Measure 15 has a dynamic marking of "f poss.". Measures 0-5 show a melodic line with notes and rests, including a "f poss." marking.
- Vib** (Vibraphone): Measures 7-15 show a melodic line with notes and rests. Measure 10 includes a "P" marking. Measure 15 has a dynamic marking of "f poss.". Measures 0-5 show a melodic line with notes and rests, including a "f poss." marking.

The score includes various musical notations such as notes, rests, dynamics (f, mf, p, mp, f poss., ppp!), and articulation marks (accents, slurs). A "Ped" (pedal) marking is present at the bottom of the page.

★ Brilliant! Execute the flourish as fast and as violently as possible.

Handwritten musical score for a percussion ensemble, featuring measures 5 through 19. The score is written for the following instruments:

- T. Rec.
- DX7 I
- DX7 II
- Rin/ Tub Bells
- CBT coil
- Δwc
- Crot
- Vib

The score includes various musical notations and performance instructions:

- Measures 5-10:** T. Rec. part with notes and rests. DX7 I and II have a "Ped" (pedal) instruction.
- Measure 11:** T. Rec. part with a note marked "optional". DX7 I and II have a "Ped" instruction.
- Measure 12:** T. Rec. part with a note marked "N". DX7 I and II have a "Ped" instruction.
- Measure 13:** T. Rec. part with a note marked "N". DX7 I and II have a "Ped" instruction.
- Measure 14:** T. Rec. part with a note marked "N". DX7 I and II have a "Ped" instruction.
- Measure 15:** T. Rec. part with a note marked "N". DX7 I and II have a "Ped" instruction.
- Measure 16:** T. Rec. part with a note marked "N". DX7 I and II have a "Ped" instruction.
- Measure 17:** T. Rec. part with a note marked "N". DX7 I and II have a "Ped" instruction.
- Measure 18:** T. Rec. part with a note marked "N". DX7 I and II have a "Ped" instruction.
- Measure 19:** T. Rec. part with a note marked "N". DX7 I and II have a "Ped" instruction.

Additional performance instructions and markings include:

- reedy** (written above measures 7, 11, 14, 15)
- serene** (written above measure 9)
- optional** (written below measure 11)
- N** (written below measures 7, 11, 12, 14, 15, 16, 17, 18)
- Vib** (written above measure 13)
- sffz** (written below measures 13, 14, 15)
- f** (written below measures 13, 14, 15)
- ff** (written below measure 15)
- Rin** (written above measure 16)
- f poss.** (written below measure 16)
- 7 6 1 2 5 3** (written below measure 16)
- DX7 II** (written above measure 13)
- f poss.** (written below measure 13)

"suspended time" 19 20 21 22 23 24 25 26

full, resonant, steady...

one full breath

sfffz:p mf f mf

DX7 I

f poss.

- Ped

DX7 II

sfffz

- Ped

Rin/
Tub Bells

"suspended time" 19 20 21 22 23 24 25 26

Tub Bells

Ped f

damp all resonances

CBT
coil

ΔWC

Crot

Vib

f poss.

- Ped

⑥

★

FINE.

★ If the vibraphone's pedal cannot be kept depressed while playing the tubular bells, then either omit this chord altogether (as a last resort), or, better still, sustain the pedal-depression as long as possible - past 24".

5.2 ARC OF LIGHT

5.2.1 INTRODUCTORY REMARKS

Arc of Light: Origins

As its name might insinuate, **Arc of Light** is indeed a companion piece to – really, just a minor offshoot of – my coruscant creation **Lines of Light: Seven Improvisations on αιθερος μελος** (1993). Anyway, several weeks prior to my humorous telephone conversation with Robert Allworth which prompted me to write **Arc of Light** (as reported in its Programme Annotation), the seeds for **Arc of Light**'s composition were sown by a former recorder student of mine, Joan Tucker: I remember playing through **Lines of Light**'s eight 'harmonic fields'¹ for Joan on my old upright piano, after which Joan remarked that she thought its harmonies could easily be developed into an excellent little piano piece.

So **Arc of Light** – a distillation of **Lines of Light: Seven Improvisations on αιθερος μελος** – was fully fleshed-out and notated in its final format within a period of just over three hours, on 4.12.1993. (In retrospect, perhaps I ought to have dedicated this work to Joan as well as to my dear friend Robert Allworth?)

An Overview of Arc of Light

Arc of Light is “a contemplative study in *time*, *resonance*, and *colour*”² whose title surely connotes rainbows. But beyond that well-known story told in Genesis 9:8–17, of the rainbow as symbol of a covenant between Noah (i.e. humankind) and God, the rainbow itself is rich in imagery:

The rainbow is frequently a symbol of the union of heaven ... and earth. According to Talmudic tradition, the rainbow was created on the evening of the sixth day of Creation. In Greek mythology, the rainbow is the embodiment of the messenger of the goddess Iris; in Germanic mythology, it is the bridge Bifröst joining Asgard and Mid-gard. After the Flood, God placed a rainbow in the sky as a sign of His covenant with humans; in medieval depictions of Christ as ruler of the world, for example, Christ reigns on a rainbow, which is to be understood in this sense. Thus, the rainbow also became a symbol of Mary, the intermediary of reconciliation. The symbolic interpretation of the colors of the rainbow depends on how many colors one distinguishes; in China, for example, five colors of the rainbow are recognized, their synthesis symbolizing the union of Yin and Yang. In accordance with the Aristotelian tradition of a three-fold division, only the three primary colors (a symbol of the Trinity) are distinguished in Christianity; yet the colors blue (the water of the Flood or the heavenly origin of Christ), red (the coming destruction of the world by fire or the

Passion of Christ), and green (the new world or Christ's workings on earth) are also distinguished. ...

The rainbow, a striking and central symbol and sign, articulates man's hope for a better world. Is it any wonder that the rainbow, one of the greatest symbols, became the one that was most misused, robbed of its meaning, and commercialized? If one pursues the history of the rainbow symbol back to the beginnings of literary tradition, then we find the rainbow in Babylonian literature as a sign of wrath, of terror, and of ill, and as an attribute of the goddess Tir-an-na, bringer of misfortune. This aspect also appears in ancient Jewish writings. Specifically, an apocryphal writing claims that God removed the layer of wrath from the bow in the clouds, meaning that He detached the band of fury from the devastating waters of the Flood, which came from the high windows of heaven, and then spread out the bow in the clouds: instead of the flood waters, the rainbow, created on the eve of the first sabbath, now shines as the arch of peace. Thus, the rainbow underwent a complete change in meaning: the bow went from being a symbol of wrath and terror of the goddess Tir-an-na to the symbol of peace, the sign of the covenant between Yahweh and man.

In this context, Alfons Rosenberg has an interesting idea. In particular, he suspects that the bow mentioned in Genesis 9:8–17 does not at all refer to a rainbow, but rather to the arc of the zodiac. This would indeed be a much deeper embedment of the mundane event of the Flood in a larger, more comprehensive cosmic context than would be possible with the rainbow image.³

What is **Arc of Light**'s compositional relationship to **Lines of Light: Seven Improvisations on αιθερος μελος**? Although this piano solo's Programme Annotation declares that (like **Lines of Light**) it is "similarly concerned with rainbows",⁴ this connection is more metaphoric than physical. For whereas one of **Lines of Light**'s chronomorphological sources is a quite literal conversion of Fraunhofer-line wavelengths into durational ratios, the macrotemporal proportions in **Arc of Light** are only *very rough* approximants of this solar-spectral phenomenon. Yet despite the disappearance of my sketch-materials to **Arc of Light**, I can, however, definitely state that the 'Fraunhofer ratios' were, for the most part, considerably warped on account of my wish to accommodate the ample resonances of a concert grand piano.

Arc of Light encompasses only eight bars; yet each bar corresponds to one of those eight 'harmonic fields' upon which **Lines of Light: Seven Improvisations on αιθερος μελος** is grounded. Again, this bar-to-field correspondence is rather loose: some new pitches have been added, while others were removed; the tessitura of the harmonic space was expanded so as to capture the grand piano's pitch-extremities; and certain pitches have been transposed into another octave-register.

The following table summarizes the situation for **Arc of Light**:

Bar	Harmonic Field (from <i>Lines of Light</i>)	Bars' Durations * (in seconds)
1	Field 1	$A_1 \approx 14.64''$
2	Field 2	$A_2 \approx 8.75''$
3	Field 3	$A_3 \approx 6.41''$
4	Field 4	$A_4 \approx 8.56''$
5	Field 5	$A_5 \approx 10.31''$
6	Field 6	$A_6 \approx 10.82''$
7	Field 7	$A_7 \approx 21.68''$
8	Field 8	$A_8 \approx 19.24''$

* In live performance, the bars' durations will be rendered ambiguous by various pauses and by florid grace-note groups. This is particularly the case for bar 8, at the end of which the pianist is instructed to "Pause until all resonances decay into complete silence . . . Then pause for a few moments longer": such a stasis will certainly be held for many seconds – indeed, probably much longer than the span of A_8 itself.

How well do these figures for bar-durations in **Arc of Light** correlate with the sectional spans – S_1 to S_6 – of **Lines of Light: Seven Improvisations on αιθερος μελος?**⁵ The bond of proportionality between these two compositions is, in fact, not very strong: there appear to be only two rather close matches of durational ratio:

1. $S_2:S_1 \approx 1.626 \approx \Phi = ((\sqrt{5} + 1) \div 2)$ and $A_5:A_3 \approx 1.608 \approx \Phi$;
2. $S_6:S_1 \approx 3.032$ and $A_8:A_3 \approx 3.002 \approx 3:1$.

Note also that $A_4:A_3 \approx 1.335 \approx 4:3$, and $A_7:A_6 \approx 2.004 \approx 2:1$. Such integral ratios constitute a harmonic series at the *formal* level – i.e. 'structural harmonics'.

ENDNOTES

1. See section 5.1.1, and pp.5.1.3–5.1.4 in particular.
2. **Arc of Light**, Programme Annotation.
3. Becker (1996), pp.243–245.
4. **Arc of Light**, Programme Annotation.
5. The values (in seconds) for S_1 to S_6 were tabulated within section 1.2.4.

Ian Shanahan (4.12.1993)

– *To Robert Allworth*

For Simon Docking to play:

~~~~~

# *Arc of Light*

for

solo (concert grand) piano

~~~~~

PROGRAMME ANNOTATION

Arc of Light

for solo piano

Ian Shanahan (4.12.1993)

Dispersed sunlight, refracted through atmospheric raindrops = a rainbow = an **Arc** {of The Covenant [Jewish Mythology]} of **Light**, that “immense arc of light which touches the earth and makes it sing” (Arp).

This unassuming little piece – brief and deliberately rather straightforward, to entice the timid – is an offshoot of my recent trio **Lines of Light: Seven Improvisations on αιθερος μελος** (similarly concerned with rainbows) in that it derives from the same harmonic fields, and possesses roughly comparable macrotemporal proportions. (Indeed, it would be ideal if both pieces could be programmed within the same concert...)

Arc of Light is gratefully dedicated to my dear friend and colleague, the composer and CD producer Robert Allworth, who was responsible for the work’s ‘Genesis’. Robert telephoned me on December 4, and an amusing dialogue ensued:

“Ian, I’m producing another CD and would love to include a short piano piece of yours ... say, about two minutes long. Do you have one available?”

“Sorry, Robert – No, I haven’t...”

“Could you write one then, and deliver it to me today?”

[stunned silence fills a very uncomfortable pause, while I reflect upon my usual tortuously slow rate of composition] ... “Yes!” (And three hours later, I completed my ‘**Arc**’!)

Anyway, **Arc of Light** is a contemplative study in *time, resonance, and colour* – hopefully not too difficult to perform. While writing this compact work, I had the talented young Australian pianist Simon Docking in mind to première and record it.

© Ian Shanahan, Sydney, Australia; 4 December 1993.

PERFORMANCE NOTES

CHRONOMORPHOLOGY, AND INTERPRETATION

Arc of Light is presented entirely in *time-space notation*, with each numbered ‘ictus’ corresponding to *one second, or slightly more* of elapsed time – although a reasonable degree of executative freedom is permissible here, even desirable. Therefore, musical events should be deployed chronometrically in direct proportion to their relative horizontal placement upon the score-page: an electronic metronome flashing once per second might prove to be an effective practice tool in this respect. Yet any sense of metricated rigidity is strongly discouraged! (It might be worthwhile in this regard to observe that durations of resonances are all *unequal*: so, complete temporal *asymmetry* ought to be strived for.) Within this time-framework, **grace-note groups** are to be played ‘as quickly as possible’, or at the very least quite rapidly; **beams** define ‘connected events’ (phrases).

All *pedalling* is well-specified, as are all nuances of *dynamic level*, from “*p poss.*” (as soft as possible) to “*f poss.*” (as loud as possible). Please respect these instructions. Also, *suggestions* are made for **the disposition of the hands**.

© Ian Shanahan, Sydney, Australia; 4 December 1993.

Arc of Light, commissioned by Robert Allworth, was premièred by Simon Docking at The Old Darlington School, the University of Sydney, on 14 August 1994.

Two recordings of **Arc of Light**, played by Simon Docking and Roger Dean, are now commercially available on the Compact Discs “Australian Music for Film: Remembering Adrian Braun” and “Lines of Light” (Broad Music Records Jade JAD CD 1073 and JAD CD 1091, respectively). The score has been published by Grevillea Editions (The Yitpi Series [ISBN 1-876266-54-6]), Maybole via Ben Lomond, NSW, Australia.

Arc of Light

Monolithic, but glistening like a rainbow: hieratic. "Music of the Spheres".

brilliant, as fast
and violent
as possible. hh

~ 1 second, at least.

 begin time-count.

 f

 poss

[illegible]

Handwritten musical score for three staves, measures 11-14. The score includes dynamic markings such as *sffz*, *ff*, *mp*, *ppp*, and *mf*. Performance instructions include "subtle; a slightly uneven arpeggio." and "u.c.". A pedal point is indicated by a line labeled "Ped." at the bottom. The notation features various accidentals, slurs, and articulation marks.

Handwritten musical score for three staves (treble, alto, and bass clefs). The score is divided into measures 1 through 6, with measure 6 being a double bar line. The notation includes various musical symbols such as notes, rests, and dynamic markings.

Measure 1: Treble clef, key signature of one flat (B-flat). Notes: B-flat, A, G, F, E, D, C, B. Dynamics: *ff*. Pedal: Ped. (pedal point).

Measure 2: Treble clef, key signature of one flat (B-flat). Notes: B-flat, A, G, F, E, D, C, B. Dynamics: *ff*. Pedal: Ped. (pedal point).

Measure 3: Treble clef, key signature of one flat (B-flat). Notes: B-flat, A, G, F, E, D, C, B. Dynamics: *ff*. Pedal: Ped. (pedal point).

Measure 4: Treble clef, key signature of one flat (B-flat). Notes: B-flat, A, G, F, E, D, C, B. Dynamics: *ff*. Pedal: Ped. (pedal point).

Measure 5: Treble clef, key signature of one flat (B-flat). Notes: B-flat, A, G, F, E, D, C, B. Dynamics: *ff*. Pedal: Ped. (pedal point).

Measure 6: Treble clef, key signature of one flat (B-flat). Notes: B-flat, A, G, F, E, D, C, B. Dynamics: *ff*. Pedal: Ped. (pedal point).

Handwritten annotations and performance instructions:

- brilliant; as fast and violent as possible.*
- begin time-count.*
- a slightly uneven arpeggio, as before.*
- aggressive.*
- stffz* (staccato fortissimo)
- ff* (fortissimo)
- mf* (mezzo-forte)
- f poss.* (forzando)
- Ped.* (pedal point)

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CHAPTER 6. TRANSFINITE NUMBERS AND CHRISTIAN MYSTERIES

6.1 153 INFINITIES

6.1.1 FURTHER ANALYTICAL NOTES¹

Prolegomenon

As my Programme Annotation to **153 Infinities** attests, the premature and inexplicable demise of Doug White prompted me to meditate upon (among other things) the mystery of Jesus: how could God, the Infinite One, become incarnate as a man – mortal and limited? A partial insight into this paradox – something that seems almost incommunicable – gradually bubbled to the surface of my consciousness, in the form of *transfinite numbers*.

What, then, are ‘transfinite numbers’?² They are an outgrowth of the theory of sets “as developed by [the German mathematician Georg Cantor (during the latter half of the nineteenth century) which] has not only influenced and enriched almost every branch of mathematics but has also helped to clarify the relationship between mathematics and philosophy”.³ If we consider the infinite set \mathbb{N} of ‘natural numbers’ $\{1, 2, 3, \dots, k, \dots\}$, then any other infinitely large set that can be put into one-to-one correspondence with \mathbb{N} is said to be *denumerable* (i.e. countable) and therefore possesses the same *cardinality*: the number of elements in such denumerably infinite sets is identical, and this cardinality is denoted by \aleph_0 – the ‘countable infinity’. Examples of infinite sets with cardinality \aleph_0 include the integers, odd or even numbers, all rational numbers, and algebraic numbers.⁴ However, it turns out that the set of *transcendental numbers* – i.e. irrational numbers which are *not* algebraic – is *indenumerable*, and so too is the set \mathbb{R} of all real numbers:⁵ they are innately uncountable, and their cardinality is thus some ‘denser’, higher order of infinity – \mathfrak{c} (for ‘continuum’).

So \aleph_0 and \mathfrak{c} are both distinct transfinite numbers, of which there are infinitely many more – $\aleph_1, \aleph_2, \aleph_3, \dots, \aleph_k, \dots$ – that one may formulate by defining the *power sets* \wp (i.e. set of all subsets) of \mathbb{N} and of \mathbb{R} ... and so forth, reiteratively,⁶ in an endless hierarchical chain of transfinitudes, *ad infinitum*.

These are some of the successes of [Georg] Cantor’s work; but there was one problem that he sought constantly to solve. He was never successful and many of his

periods of mental disturbance and depression seem to have been exacerbated by his failures. Later, we shall have more to say about this problem. It is far harder, and its implications far deeper and wider, than Cantor ever suspected in his troubled lifetime. It is called the 'Continuum Hypothesis'.

Cantor raised the intriguing question of whether there exist infinite sets which are intermediate in size between the natural numbers and the real numbers; that is, infinite sets with cardinality in-between \aleph_0 and \mathfrak{c} . Cantor thought that there could not be, but was unable to prove it. The problem remains unsolved to this day. Nonetheless, Kurt Gödel and a young American mathematician Paul Cohen demonstrated some deep and unusual things about it. Gödel showed that if we merely treat the continuum hypothesis as an additional axiom and add it to the conventional axioms of set theory, then no logical contradiction can result. But then in 1963 Cohen showed that the same thing would happen if we added the negative of the continuum hypothesis to the axioms of set theory. Therefore the continuum hypothesis is independent of the other axioms of set theory (just as Euclid's parallel postulate was eventually shown to be independent of the other axioms of plane geometry) and therefore can be neither proved nor refuted from those axioms. ...⁷

So, the fact that a 'bigger infinity' resides in the cardinality of those irrational numbers between 0 and 1, than amongst that of all of the rational numbers between $-\infty$ and $+\infty$, did provide some solace for me while I was contemplating the mystery of Jesus: perhaps a transcendental infinity could indeed be embedded into a human finitude. Georg Cantor himself was also very acutely aware of the theological implications of transfinite numbers:

... [Cantor] retreated from mathematics, recognizing that his intense concentration upon particular mathematical questions [such as the Continuum Hypothesis] was beginning to affect his mental equilibrium. He began to explore the philosophical and theological ramifications of his work on infinities and published in philosophical journals. There his work was welcomed, especially by Catholic theologians who believed it to be of fundamental importance to their conception of God and the Universe and were anxious to fulfil Pope Leo XIII's call to incorporate the insights of science into the Catholic world-view. Cantor was a passionate theologian with a detailed knowledge of his subject and, predictably, [had] deep worries that the Church would fall into serious error if it ignored his discoveries. ...⁸

But if there are *infinitely many* transfinite numbers, why "**153** Infinities" in particular? Beyond the triangularity of the number 153 itself,⁹ the title of my composition **153 Infinities** refers obliquely to the 153 fishes – caught in a net, then counted – as described within John 21. The narrative therein ultimately symbolizes the judgement thence redemption of true Christians (of whom Doug White was one), who are apparently classified into 153 groups.¹⁰

Who, though, is the judge and redeemer here? Surely it is our triune God, represented within **153 Infinities** by its three 'zones' of percussion instruments – the music of which encapsulates several sets of 'triangular durations':

Player	Instruments	Location	Sum Total *	a_k (in order), $k \geq 1$; t **
1	brake drum	ca.27.3"–ca.30.9"	145.00 mm	41.43 mm, 34.52 mm, 27.62 mm, 20.71 mm, 13.81 mm, 6.90 mm †
2	almglocken 2 & 3 ‡	ca.7.4"–ca.9.5"	85.00 mm	14.17 mm , 28.33 mm, 42.50 mm
2	almglocken 4 & 5	ca.7.2"–ca.10.8"	143.50 mm	71.75 mm, 47.83 mm, 23.92 mm †
2	almglocken 4 & 5	14"–ca.19.4"	215.00 mm	21.50 mm , 43.00 mm, 64.50 mm, 86.00 mm
2	Chinese cymbal	ca.8.6"–ca.13.4"	188.70 mm	62.90 mm, 50.32 mm, 37.74 mm, 25.16 mm, 12.58 mm †
4	sleighbells	ca.19.8"–ca.29.3"	378.00 mm	10.50 mm , 21.00 mm, 31.50 mm, 42.00 mm, 52.50 mm, 63.00 mm, 73.50 mm, 84.00 mm
6	brake drum	ca.1.3"–ca.5.3"	160.00 mm	16.00 mm , 32.00 mm, 48.00 mm, 64.00 mm
6	autocoil	ca.15.2"–ca.18.7"	138.20 mm	55.28 mm, 41.46 mm, 27.64 mm, 13.82 mm †
6	tam-tam, Javanese gongs 1 & 2	27"–ca.31.3"	173.00 mm	4.81 mm , 9.61 mm, 14.42 mm, 19.22 mm, 24.03 mm, 28.83 mm, 33.64 mm, 38.44 mm

* NB: sum-total values *in italics* were decided upon first; and then their attack-endpoints were carefully positioned within the musical flow, prior to (or in conjunction with) calculating the internal a_k .

** Each arithmetic progression $\{a_k\}$ can be converted into a duration-set $\{d_k\}$ by way of the time-space equation: 1 second = 40 mm. All quantities pertaining to t – i.e. those additive constants from which each arithmetic progression $\{a_k\}$ was generated – have been set in **bold-face** type.

† These 'triangular duration-sets' are played *in reverse order* ($d_n, d_{n-1}, \dots, d_3, d_2, d_1$), accelerating as their d_k truncate arithmetically.

‡ Here, all attack-points for almglocken 1 were 'freely composed' – not being regulated by any polygonal-duration schemata throughout this region.

Buried within **153 Infinities**' six percussion parts (whose dissipative density-signatures do guarantee eventual assimilability by human audients), there are, in all, twenty-eight sets of durations that have been generated by mathematical functions.¹¹ As befits the Divine, the numbers 6 and 28 are both *perfect* – i.e. their proper divisors sum to the number itself: $6 = 1 + 2 + 3$; and $28 = 1 + 2 + 4 + 7 + 14$. Such 'perfect numbers' are also inherently triangular.¹²

Furthermore, 28 is

... [a] lunar number, since all four phases [of our Moon] are traversed in 28 days [which also happens to be the period of the female menstrual cycle]. $4 \times 7 = 28$ plays a role in the cult of Mithra and wherever 7 is already prominent. In Islamic tradition, there are said to have been 28 prophets before Mohammed.¹³

The Interrelationship Between 153 Infinities and Arc of Light

My Programme Annotation to **153 Infinities** concedes that this composition's design is essentially mosaic, with "a tapestry of material taken from two of my piano solos, **Arc of Light** and (the still unfinished) **Gate of Remembrance**, [being] transformed through expansion and rarefaction; it was composed as a prayer in memory of Doug White".¹⁴

Below is a table which collates **153 Infinities**' and **Arc of Light**'s dispositions of musical

elements; however, a comparison of their scores reveals that the more recent piece – **153 Infinities** – almost never quotes exactly from the earlier work (**Arc of Light**), unmodified:

153 Infinities (piano part)	Arc of Light
p.1 first grace-note group and 0" to ca.26.5"; ca.25"–ca.26.5" — fresh material	Bar 1, with ca.2"–ca.4.3" omitted
p.1 0" (third system) to 21" (p.2); grace-note group starting at 21" — fresh material	Bar 3 (ca.5.7"), Bars 4 & 5 *
p.2 0" to ca.104.4" (p.5) — fresh material: 'mandala 1' (from Gate of Remembrance)	—
p.5 grace-note group before 0" to 44" (p.6); "tolling bells" (in arithmetic series) — fresh material	Bar 8 (to 4")
p.6 0" to ca.35.7" (p.7) – NB: the B ₄ at ca.34.5" is a remnant of the 'tolling bells' passage	Bar 8 (ca.12" to the end)
p.7 0" to ca.37.6" (p.8); 23"–24" and ca.36.1"–ca.37.6" — fresh material	Bars 6 & 7
p.8 first 'omphalic' grace-note group — fresh material: from Gate of Remembrance	—
p.8 0" (third system) to ca.79.5" (p.10) — fresh material: 'mandala 2' (from Gate of Remembrance) †	—
p.10 second 'omphalic' grace-note group — fresh material: from Gate of Remembrance	—
p.11 ascending grace-note group, which will also comprise the final gesture of Gate of Remembrance	—

* NB: Bar 2 from **Arc of Light** was *not* reworked (or even referred to) within **153 Infinities**.

† The pluriform geometrical rhythmic design of this 'mandala-like' passage has already been analysed within section 1.2.11.1.

On the Derivation of the Percussion Music within 153 Infinities

While expanding upon my circumvention of anthropomorphism within **153 Infinities**, its Performance Notes also offer some insights into the procedures at play within its percussion music: "Nor ... does my Holy Trinity [portrayed by the three 'zones' of percussion instruments] speak in any human tongue; instead, 'Divine utterance' is simulated through recurrent yet enigmatic pitch-sequences and complex – often mathematically generated – durational and timbral patterns ... a kind of dazzling non-verbal 'glossolalia'".¹⁵ Probably the key words herein are "recurrent yet enigmatic ... patterns". Pitch-structures and temporal processes cross-pollinate from **153 Infinities'** piano part into its keyboard-percussion music – harmonies and "mathematically generated" durational sequences in particular. Now aside from my standard aspiration towards a high degree of compositional unity, such interreferentiality symbolizes, 'holographically', the Judaeo-Christian outlook of 'Man being made in the Image of God'

(since it is my intention that **153 Infinities**' piano part stands as a metaphor of human life-experience).¹⁶

The following table – taken straight from my sketch-materials – provides a rather perfunctory overview of the pitch-sources and -processes from within **153 Infinities**' keyboard-percussion music. One is thereby able to distinguish a somewhat loose allegiance to certain bars from **Arc of Light** (and hence to those 'harmonic fields' which lie behind **Lines of Light: Seven Improvisations on αιθερος μελος**):

NB: if Z is some set, then I denote its *complement* (i.e. that collection of objects which do *not* belong to Z) as \bar{Z} . Notice also that the plus symbol "+", as used below, is synonymous with the standard mathematical sign for set-theoretic 'union' – viz. " \cup ".

	Percussion Zone 1	Percussion Zone 2	Percussion Zone 3
5" bar	Arc of Light , bar 7 = Z_1	Arc of Light , bar 8 = Z_2	Arc of Light , bars 1–2 = Z_3
8" bar	Z_1 (plus some of Z_1)	Crotales: Z_2 (plus some of Z_2) Vibraphone: Z_2	$Z_3 + Z_3$
13" bar *	$Z_1 + Z_1$	$Z_2 + Z_2$	$Z_3 + Z_3$

* NB: the pitch-material of the 13" bar here is, very generally speaking, the 'sum' – or a kind of 'pitch-accumulation' – of the previous two bars.

ENDNOTES

1. Numerous analytical points concerning **153 Infinities** have already been made throughout Chapter 1.
2. John D. Barrow's book **Pi in the Sky: Counting, Thinking and Being** (1992), pp.205–216 (and *passim*) provides a cogent introduction to the theory of transfinite numbers; see also Lauwerier (1991), pp.20–25. Rucker (1997), pp.53–78 (and *passim*) & pp.221–265, however, furnishes a mathematically deeper study of this topic. Regarding the concept of the Absolute Infinity, Ω , and apophatic theology, read section 1.1 (endnote no.32b); Clayton (2000) is also informative.
3. Apostol (1957), p.24.
4. *Algebraic numbers* are those of the form $z = \alpha + \beta i$ (α and β being real numbers, with $i = \sqrt{-1}$) which are solutions to some algebraic (or polynomial) equation $a_n x^n + a_{n-1} x^{n-1} + a_{n-2} x^{n-2} + \dots + a_k x^k + \dots + a_1 x + a_0 = 0$, where all of the coefficients a_k are integers and $a_0 \neq 0$. A proof of the denumerability of the (infinite) set of all algebraic numbers is sketched out in Spivak (1967), pp.368–370 {problems 20-4 & 20-5}.
5. The *indenumerability* of the set of all real numbers \mathbb{R} (and hence of the set of *transcendental numbers*) is proven in Spivak (1967), p.370 {problem 20-6 – which essentially repeats Georg Cantor's famous 'diagonal argument'}.
6. i.e. for \mathbb{N} (say) and its power set $\wp(\mathbb{N})$, one may then build the power set of its power set, $\wp(\wp(\mathbb{N}))$, thence the power set of the power set of its power set, $\wp(\wp(\wp(\mathbb{N})))$ – and so on, indefinitely. Thus we can obtain forever-increasing infinite cardinalities:

<i>Infinite Set</i>	<i>Cardinality</i>
\mathbb{N}	\aleph_0
$\wp(\mathbb{N})$	\aleph_1
$\wp(\wp(\mathbb{N}))$	\aleph_2
$\wp(\wp(\wp(\mathbb{N})))$	\aleph_3
etc.	etc.

(This table tacitly assumes the truth of Georg Cantor's "Generalized Continuum Hypothesis" [GCH]: that, for every $n \in \mathbb{N}$, we have $2^{\aleph_n} = \aleph_{n+1}$. To this day, GCH remains unproven.)

Concerning the cardinality C of \mathbb{R} , Rucker (1997), pp.247–248, proves that $C = 2^{\aleph_0}$. (Therefore, if GCH were true, then $C = \aleph_1$ would also be true.)

7. John D. Barrow: **Pi in the Sky: Counting, Thinking and Being** (1992), pp.214–215.
8. *ibid.*, p.203.
9. Numerical triangularity signifies the Holy Trinity. See, also, section 1.2.11.1 (endnote no.8).
10. This covert theological interpretation of John 21 is supported by Bullinger (1967), pp.273–278, and by Harrison (1994), pp.83–100 (and *passim*); read also Bligh Bond & Lea (1977), pp.50–52 (and *passim*), as well as Michell (1988), pp.174–178 – both of which include *geometrical* exegeses of this enigmatic scriptural passage.
11. Consult section 1.2.11.2 and section 1.2.11.3 respectively, for the tabulations of **153 Infinities'** geometric durational-progressions and 'logarithms' within its six percussion parts.
12. Given the *Mersenne prime* $M_n = 2^n - 1$ (wherein n must itself be a prime number), $P_n = 2^{(n-1)} \times M_n$ will automatically be a *perfect number*. But the fact that $P_n = M_n \times (M_n + 1) \div 2$ also proves that P_n is the M_n th *triangular number*. (The first four perfect numbers are 6, 28, 496, and 8128.)

13. Becker (1996), p.95.
14. **153 Infinities**, Programme Annotation.
15. **153 Infinities**, Performance Notes, p.iii.
16. Regarding such imagery, peruse section 1.2.8.

Ian Shanahan (1996)

– *In Memoriam Doug White*

To Gary Monger and Jan Crispe;
For Roger Woodward to play:

~~~~~

# *153 Infinities*

for

solo (concert grand) piano

and

*optional* percussion {6 players}

~~~~~

PROGRAMME ANNOTATION

153 Infinities

for solo piano

Ian Shanahan (1996)

If the doors of perception were cleansed, everything would appear to man as it is, infinite.

– William Blake: **The Ancient Tradition.**

God manifested himself to me as the infinite void; but it was not the abyss; it was the vault of heaven ... He was not some foreign God but the God of my fathers. He was loving and kind and he had personality. He said, "You suffer a little now in life; it is little compared with the great joys, the bliss that awaits you. Do you think I in my theodicy would allow you to suffer greatly in proportion to your reward?" He made me aware, then, of the bliss that would come; it was infinite and sweet. He said, "I am the infinite. I will show you. Where I am, infinity is; where infinity is, there I am ..."

– Philip K. Dick: quoted from Lawrence Sutin's biography of "PKD" **Divine Invasions: A Life of Philip K. Dick**, p.269.

153 Infinities is a tapestry of material taken from two of my piano solos, **Arc of Light** and (the still unfinished) **Gate of Remembrance**, transformed through expansion and rarefaction; it was composed as a prayer in memory of Doug White.

Although I never knew Doug personally, his terrible affliction and death moved me very deeply – a virtuous and righteous young man, in the prime of his life, inexplicably cut down. The powerful mysteriousness of this tragedy compelled me to ponder certain imponderables, in a search for any ultimate meaning therein. So, various questions arose in my mind, such as: *What is the nature of Eternity? And how is the One who is Limitless and Transcendent made immanent throughout the fabric of bounded Time/Space?* Of course I have no definitive answers, but, as a provisional utterance, perhaps 'eternity' is *timelessness*: the enfolding of all-time into an always-now, immutable, truly infinite; an ecstatic detachment from Time's unyielding flow. (Through its eschewal of mundane pulse and its obsession with piano-resonance colours and silence, **153 Infinities** attempts to capture at least something of the essence of eternity. Indeed, it was my intention to name this piece "153 Eternities" – until I became aware of that title's unfortunate connotations of New Age fraudulence and idiocy.)

As to the second question, one can perceive in the divine personage of Jesus a *rapprochement* of transcendence (infinite) and immanence *within our universe*. By what mechanism, though, are these two polarities reconciled in and through Him? *That* hypostatic mystery is entirely beyond my understanding, I confess ... Yet, via pure mathematics, I do obtain some comfort from the existence of *transfinite numbers*: cardinalities of diverse infinite sets. For instance, the endless series of all 'rational numbers' (quantities expressible as fractions) is *countable*, in that it can be put into one-to-one correspondence with the set of positive integers {1, 2, 3, 4, ...}. Richly embedded amongst the fractions between 0 and 1 there is, however, an infinitude of 'irrational numbers' which is *uncountable* – an altogether higher order of infinity, bracketed by finite limits!

It turns out that there are infinitely many distinct infinities, or 'transfinitudes'. Why, then, do I stop at 153? Now aside from the fact that it is the 17th triangular number (i.e. $1 + 2 + 3 + \dots + 17$) – a property of 153 observed by St Augustine of Hippo – all I have to say is ... read Chapter 21 of **The Gospel according to John**. (A further riddle: the late Doug White is 'one of the 153'.)

Commissioned by the Sydney Spring International Festival of New Music with funds provided by the Australia Council for the Arts, **153 Infinities** was composed for the prodigiously talented pianist Roger Woodward to play; it harnesses Roger's extraordinary finger-power and control in eliciting a galaxy of pianistic 'touches'. This work is also dedicated to Gary Monger and Jan Crispe – in close friendship. Throughout the tribulations of late 1995, Gary and Jan were always there for me. (They too are 'among the 153'.)

© Ian Shanahan, Sydney, Australia; 25 April 1996.

153 Infinities was premiered by Tamara Anna Cislowska (piano) and the Sprung Percussion Ensemble (Guy du Blêt, Claire Edwardes, Richard Gleeson, Kevin Man, Luke McAvenna, and Timothy Paillas) during the Eighth Sydney Spring International Festival of New Music, Eugene Goossens Hall, ABC Centre, Harris Street, Ultimo, Sydney, on 12 September 1997. Subsequently, this work was nominated for a **1998 Sounds Australian National Award**, for the Best Composition by an Australian Composer performed during 1997.

A recording of **153 Infinities**, played by the same personnel, is now commercially available on the Compact Disc "Solar Dust" (Broad Music Records Jade JAD CD 1080).

The solo grand piano version of **153 Infinities** (i.e. without its array of optional percussion instruments) was premiered by Zubin Kanga (piano) at the Great Hall, the University of Sydney, Sydney, on 2 April 2003.

A recording of the solo grand piano version of **153 Infinities**, played by Zubin Kanga, is now commercially available on the Compact Disc "Morning By An Ocean" (Broad Music Records Jade JAD CD 1100).

PERFORMANCE NOTES

OPTIONAL PERCUSSION {6 PLAYERS}

If the optional percussion parts are to be realized in concert, I request that they *not* be mentioned anywhere in the publicity or in the Programme Annotation to this work – lest the surprise impact of their musical entry be spoilt! Rather, the pianist is to post-announce the six percussionists verbally, or instead credit them elsewhere within the printed programme.

STAGING AND LIGHTING

Ideally, only a small area encompassing the piano and pianist should be spotlighted, with the rest of the performance space – in particular, the percussion instruments and their players (if present) – remaining in total darkness, unseen. At the pianist's cue near the end of the piece (viz. *their hands being lifted and brought together in an attitude of prayer* [p.10]), spotlights suddenly snap on all three of the 'percussion zones' – which must be deployed towards the rear of the performance space, remote from both pianist and audience (as depicted below).

It is also strongly recommended that the pianist makes use of a *page-turner* in concert.

AMPLIFICATION OF THE PIANO

The grand piano ought to be amplified *for the entire work* whenever the percussion is utilized or *whenever the solo piano version is presented in a concert hall*.

THE NOTATION OF TIME

153 Infinities is notated entirely in *time-space notation*, with each numbered 'ictus' corresponding either to **one second**, or **slightly more** or **one second exactly** of elapsed time; **beams** define 'connected sounds'. Therefore, musical events should be deployed chronometrically in direct proportion to their relative horizontal placement upon the score-page; yet any sense of metricated rigidity is strongly discouraged! (Complete temporal *asymmetry* ought to be strived for.) An electronic metronome flashing once per second might prove to be an effective tool in this respect.

Grace-note groups all lie 'outside time' – locally independent of the time-space paradigm – and are to be played "as fast as possible", or at the very least quite rapidly. (A tenuto marking is used to suggest a more leisurely pace.) Most grace-note groups occur either as an 'upbeat' or an 'afterbeat' to some other sonority, whose timing will define the placement of any contiguous grace-note groups.

As fast as possible (in conjunction with a grace-note group) constitutes a 'local tempo' which will always be entirely dependent upon certain factors, such as the distance (and direction) your hands must traverse along the keyboard from one sonority to the next, dynamic level, fingering, the weight and responsiveness of the piano's keys, the mandatory attainment of clarity (that each sonority still must be clearly discernible), your pianistic virtuosity, how well you feel, room acoustics, etc. "As fast as possible" is, therefore, 'micro-contextual' and potentially forever variable – a precise directive without a predictable outcome! So, for this mode of performance, do not necessarily strive for evenness of speed: rather, rhythmic fluidity, naturalness and – where applicable – asymmetry should be your goals. (Think of the continuity of a fast-flowing river, with its ceaselessly evolving inner turbulences, eddies, whirlpools, and its more sedate currents.)

Pauses are always notated with a **large rectangular fermata** (≡), over which is given either **the number of seconds' rest** or an instruction – ... **silence** – to wait until all piano resonances have decayed into complete silence before moving on.*

* With the latter case, the pianist in practice really needs to gauge the exact moment 'silence' first arrives *from the audience's perspective*, even though they themselves might still be able to hear (very) faint sounds emanating from within the piano.

OTHER NOTATIONS

Diamond-shaped noteheads (▷) instruct the pianist to **depress the corresponding keys silently**: it is recommended that the hands remain in position, poised for the next event. (If it proves to be absolutely necessary, the page-turner may assist with the silent depressing of keys.)

All **pedalling** on the piano is well-specified: the pedals (from left to right) are denoted **U.C.**, **Sost** and **Ped**, respectively.

Dynamic indications, from "*p poss.*" (as soft as possible) to "*f poss.*" (as loud as possible), are occasionally affixed with arrows which denote subtle gradations of loudness. Please respect these nuances.

Also, *suggestions* are made in the piano part for **the disposition of the hands**.

OTHER DETAILS CONCERNING THE PERCUSSION

The percussionists should all **start playing together as soon as possible** after spotlights illuminate the three 'percussion zones', thereafter **coordinating attacks precisely** at the beginning of each bar (i.e. at 0", 1", 6", 14", and 27").

All percussion instruments are to be permitted to ring on indefinitely (vibraphones: the pedal is kept depressed throughout!), but any residual resonances *must* be damped by 18" after the pianist's final high note – if necessary.

The **six percussion parts** in **153 Infinities** – though rather brief – are all *very difficult* to perform with fidelity (at the notated speed), and do require a great deal of practice. If their challenging nature proves to be overwhelming for the six percussionists (through a shortage of rehearsal time, technical limitations, or whatever other exigencies), then an obvious, pragmatic – although by no means entirely desirable – solution is simply to change the scale of the time-space notation so that each numbered 'ictus' corresponds to **somewhat more than one second** of elapsed time.

It is also *essential* that three quite distinct 'percussion zones' be retained towards the rear of the performance space: each of these 'zones' is intended to symbolize one of the three persons of the Holy Trinity.†

Further information in regard to **staging and lighting**, the **initial entry of the percussion instruments**, and all aspects of **notation**, is supplied above.

† As an interesting aside, there is a small but growing repertoire of significant twentieth-century compositions in which a 'single Divinity' is represented by more than one musician or instrument – thereby avoiding an obvious anthropomorphism: in Igor Stravinsky's **Babel** (1944), the words of God are articulated by a male choir; for **The Flood** (1961–1962), Stravinsky gave the rôle of God to a duo of bass voices accompanied by an insistently-beaten bass drum (hence the composer omits bass voices from his chorus); Benjamin Britten's second Canticle, **Abraham and Isaac** (1952), conflates the voices of Abraham (tenor) and Isaac (alto) to embody the voice of God. My own method of sidestepping both the anthropomorphic trap and any danger of idolatry in **153 Infinities** has been to illustrate the Holy Trinity through a multitude of 'abstract' percussion instruments: therefore, it is *not* the percussionists who symbolize God the Father,

Jesus Christ, or The Holy Spirit, but rather the three zones of percussion instruments themselves! Nor of course does my Holy Trinity speak in any human tongue; instead, 'Divine utterance' is simulated through recurrent yet enigmatic pitch-sequences and complex – often mathematically generated – durational and timbral patterns ... a kind of dazzling non-verbal 'glossolalia'.

Detailed descriptions and abbreviations of all of the percussion instruments are now provided, below:

THE PERCUSSION INSTRUMENTS: Descriptions and Abbreviations

Within their respective parts, all percussion instruments are notated in sequential order according to their physical distribution; they are listed below in the same fashion. In any references to pitch herein, "Middle C" shall be designated as C \sharp 3, the C \sharp one octave higher as C \sharp 4, etc. (i.e. assuming that A \sharp 3 = 440 Hz, then C \sharp 3 \approx 261.6255653 Hz).

PERCUSSION ZONE 1 {"GOD THE FATHER"}

PERCUSSIONIST 1

1. Large Brake Drum: BrDr

A large resonant brake drum (from a truck or whatever), laid horizontally so that its flat surface can be struck.

2. 3 Large Japanese Temple Bells (Rin): Rin

Three large Japanese 'cup bells', resting upon their traditional cushions, which radiate extremely beautiful, mellow, resonant, microtonal bell-sounds – all exhibiting very long decay-times, no rin being higher pitched than about G \sharp 3.

3. Vibraphone: Vib

Range: F \sharp 2 — F \sharp 5. A high-quality instrument (with wide bars in the low register) is required; the vibraphone must also be equipped with an electric motor and potentiometer that will yield a medium rate of vibrato.

Mallets



Four yarn-wound vibraphone mallets of medium hardness.

PERCUSSIONIST 2

1. 'Triangle Windchime': Δ WC *

Three small triangles of different size/pitch grouped together (as a windchime) in such a way that each triangle bangs against the others without losing much of its natural resonance.

2. Brass Tube Windchime(s): BrTW *

About twenty or so medium to small thick brass tubes (outer diameter ca.6-10 mm, maximum length ca.330 mm), sounding within the range F \sharp 4 — C \sharp 7: brilliant, starry,

cutting, high-pitched; ca.10-15" decay.

3. Kenyan Bell Tree(s): KBT

About twenty or so bronze conical and cylindrical bells (with clappers), suspended in a flat diamond-shaped frame, microtonally pitched within the range C \sharp 5 — C \sharp 7: the bell tree's timbre should be a high-pitched, delicate, fairly dry jingle, rather cutting; ca.5" decay. Jolt, displace or shake the framework to activate the bells, in accord with the notated waveform contours.

4. 5 Almglocken: Alm

Five very large to medium 'herd bells', all pitched within the range C \sharp 2 — C \sharp 4 and possessing a mellow, lush, resonant timbre. The largest two or three almglocken should sound almost gong-like; their pitches must lie below C \sharp 3. Do not muffle or mute any of the almglocken!

5. Large Sizzle Cymbal: Sizz

A large, very resonant, thin sizzle cymbal, possessing a high 'sizzle' and a long decay.

6. Large Chinese Cymbal: ChCym

A (very) large, resonant chinese cymbal.

Mallets



Two yarn-wound vibraphone mallets of medium hardness.

PERCUSSION ZONE 2 {"JESUS CHRIST, THE SON OF GOD"}

PERCUSSIONIST 3

1. Crotales: Crot

Written range: C \sharp 3 — C \sharp 5, sounding two octaves higher than notated. The twenty-five crotali should be rack-mounted, in the manner of a keyboard.

2. Vibraphone: Vib

Range: F \sharp 2 — F \sharp 5. A high-quality instrument (with wide bars in the low register) is required; the vibraphone must also be equipped with an electric motor and potentiometer that will yield a fast rate of vibrato.

Mallets



Four very hard plastic glockenspiel mallets.

PERCUSSIONIST 4

1. 'Triangle Windchime': Δ WC *

Three medium triangles of different size/pitch grouped together (as a windchime) in such a way that each triangle bangs against the others without losing much of its natural resonance.

2. Large Autocoil: Coil

A large helical spring, from the front-end suspension of a car, hung up high by a leather bootlace. An arrow to the left of a notehead indicates a sweeping rasp-like 'arpeggiando' attack (either upwards or downwards) that dramatically runs along the whole length of the helix, striking most (or all) loops in rapid succession; otherwise, for the coil's normal mode of performance, tap just a single loop.

3. Sleighbells: Sleigh

A lush-sounding ribbon/loop-type sleighbell consisting of many individual pellet-bell elements, suspended high and struck (not shaken). A ghungrū (Indian bell strap) may be substituted, if necessary.

4. Chinese Bell Tree: CBT

A nested set of microtonal bells, strung together on a rod in order of size. Upward and downward glissandi – as well as their relative speeds and approximate starting positions – are notated graphically, as usual.

5. Brass Tube Windchime(s): BrTW *

About ten or so large brass tubes (outer diameter ca.18-25 mm, maximum length ca.610 mm), sounding approximately within the range E \sharp 3 — A \sharp 4: brilliant, cutting, rather like small tubular bells; ca.15-20" decay.

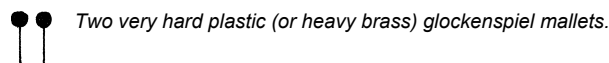
6. 2 Strings of Bronze Jingle Bells: BJB *

Each string should hold six or so small microtonally pitched bronze/brass bells (with clappers), suspended high: the bells' timbre should be high-pitched, lush and resonant. Agitate the strings to activate the bells.

7. Brass Bell Windchime: BBW

Three tiny brass/bronze bells (without clappers) spanning the range G \sharp 6 — C \sharp 8, suspended in a horizontal line with the lowest-pitched bell in the middle, touching the other two. The timbre should be very cutting: ca.5" decay. Jolt, displace or shake the bells' suspending rod to trigger a sequence of echoed attacks.

Mallets



Two very hard plastic (or heavy brass) glockenspiel mallets.

PERCUSSION ZONE 3 {"THE HOLY SPIRIT"}

PERCUSSIONIST 5

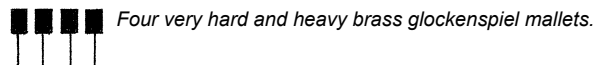
1. Glockenspiel: Glock

Written range: G \sharp 2 — C \sharp 5, sounding two octaves higher than notated.

2. Giant Orchestral Bass Drum: BD

A very large and broad orchestral bass drum (e.g. Ludwig brand): its timbre should have at least the depth of rolling thunder, infinitely low-pitched.

Mallets



Four very hard and heavy brass glockenspiel mallets.

~ v ~



A large, (very) soft woollen bass drum beater.

PERCUSSIONIST 6

1. Medium Brake Drum: BrDr

A resonant medium-sized brake drum (from a car), laid horizontally so that its flat surface can be struck.

2. Autocoil: Coil

A medium to large helical spring, from the front-end suspension of a car, hung up high by a leather bootlace. An arrow to the left of a notehead indicates a sweeping rasp-like 'arpeggiando' attack (either upwards or downwards) that dramatically runs along the whole length of the helix, striking most (or all) loops in rapid succession; otherwise, for the coil's normal mode of performance, tap just a single loop.

3. 'Triangle Windchime': Δ WC *

Three large triangles of different size/pitch grouped together (as a windchime) in such a way that each triangle bangs against the others without losing much of its natural resonance.

4. Giant Tam-Tam: T-T

A very large, resonant tam-tam – very deep, profound and mysterious!

5. 2 Large Javanese Gamelan Gongs: Gongs

Two 'nipple' gongs (large and very large) with very broad rims – extremely deep, profound and mysterious!

Mallets



Two very hard and heavy brass glockenspiel mallets.



A large, soft gong/tam-tam beater.



A large, dense, extremely bouncy, 'sticky' rubbery-plastic "superball" mallet.

* Windchimes [Percussionists 2, 4 & 6]

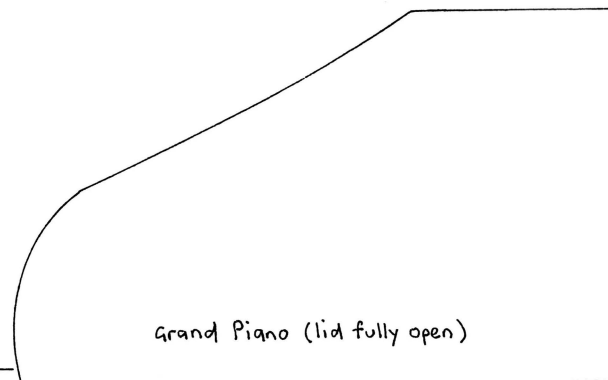
Agitate the elements of these windchimes directly, with hand(s) or mallet(s), roughly in accord with the notated waveform contours. All windchime attacks and excitations should be varied as much as possible, subject to the indicated dynamic level.

The **physical disposition** of every instrument used in **153 Infinities** is diagrammed below:

© Ian Shanahan, Sydney, Australia; 8 September 1997.

~ vi ~

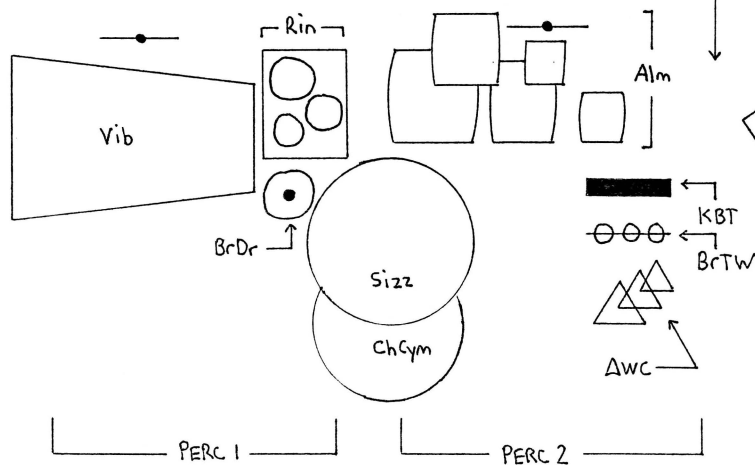
AUDIENCE



Maximum space possible!

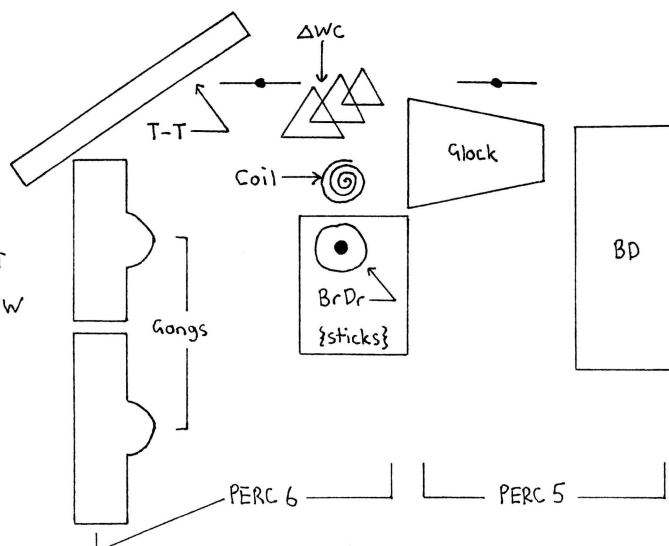
Percussion Zone 1

"God the Father"



Percussion Zone 3

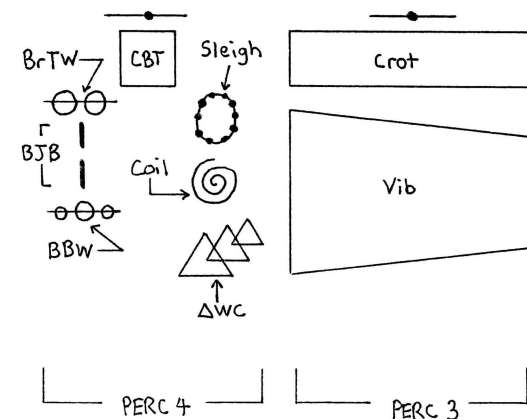
"The Holy Spirit"



c. 3 metre space between percussion zones.

Percussion Zone 2

"Jesus Christ, the Son of God"



153 Infinities

© Ian Shanahan, Sydney, Australia,
25 April 1996.

- In Memoriam Doug White.
- To Gary Monger and Jan Crispe;
For Roger Woodward to play.

$X_0 \dots$

Music of the Spheres: hieratic; glistening like a RAINBOW.

[illegible]

Handwritten musical score for three staves (treble, alto, and bass clef). The score includes dynamic markings like 'sfffz', 'pp', and 'p', and performance instructions like 'Ped' and 'Sost'. Below the staves, there are time-count markers: 'begin time-count.', 'stop time-count.', and 'resume time-count.' with corresponding bar numbers 23, 24, 25, 26, 3, 4, 5, and 6.

Handwritten musical score for three staves. The score includes performance instructions and dynamic markings.

Staff 1 (Treble Clef):

- Measures 23-24: *starry.* (dynamic *mf*)
- Measure 25: *stop time-count.* (dynamic *mp*)
- Measure 26: *... silence* (dynamic *mp*)
- Measure 27: *Be poised for...* (dynamic *f* *poss.*)
- Measure 28: *aggressive.* (dynamic *f* *poss.*)
- Measure 29: *brilliant: as fast and violent as possible.* (dynamic *f* *poss.*)
- Measure 30: *mf*
- Measure 31: *mf*

Staff 2 (Treble Clef):

- Measures 23-24: *mf*
- Measure 25: *mp*
- Measure 26: *mp*
- Measure 27: *f* *poss.*
- Measure 28: *f* *poss.*
- Measure 29: *f* *poss.*
- Measure 30: *mf*
- Measure 31: *mf*

Staff 3 (Treble Clef):

- Measures 23-24: *mf*
- Measure 25: *mp*
- Measure 26: *mp*
- Measure 27: *f* *poss.*
- Measure 28: *f* *poss.*
- Measure 29: *f* *poss.*
- Measure 30: *mf*
- Measure 31: *mf*

Performance Instructions:

- begin time-count.* (Measure 27)
- stop time-count.* (Measure 28)
- resume time-count.* (Measure 29)
- 12"* (Measure 26)
- mf* (mezzo-forte)
- mp* (mezzo-piano)
- f* (forte)
- f poss.* (forte possible)
- p* (piano)

Other Markings:

- Ped* (Pedal)
- Sost* (Sostenuto)
- mf* (mezzo-forte)
- mp* (mezzo-piano)
- f* (forte)
- f poss.* (forte possible)
- p* (piano)

6. 7. 8. 9. 10. 11. 12. 13. 14. 15. 16. 17. 18. 19. 20.

gentle, cosmic.

mf

p

Ped

Sost

p

pp

8

20

stop time-count.

As fast as possible!

Slightly slower.

rolling thunder, infinitely remote.

... silence

8

begin time-count.

1 = 1 second exactly.

Terrifying (in its inexorableness and symmetry): geometries of the Abyss!

f poss. with extreme ferocity.

with extreme ferocity.

f poss. Δ

brilliant, coruscative.

Ped

Sost

3. 4. 5. 6. 7. 8. 9. 10. 11. 12. 13. 14. 15. 16. 17.

radiant, auroral.

as fast and hard as possible.

As fast as possible! a remote (and receding) tintinnabulation of chord-tones, somewhat obscure yet lyrical, like sanctus-bells.

Ped

17 18 19 20 21 22 23 24 25 26 27 28 29 30 31

pp: ppp↓: p poss.

pp↑: ppp> pppp↓

ffff

ffff

ffff

Ped

31 32 33 34 35 36 37 38 39 40 41 42 43 44 45

p: ppp↓ = pppp

ffff↓

p↑: pp = ppp↓

p↑

fff

Ped

45 46 47 48 49 50 51 52 53 54 55 56 57 58 59

fff

mp: p↓ = ppp↓

mp

ff

Ped

□ As fast as possible!: a remote (and receding) tintinnabulation of chord-tones, somewhat obscure yet lyrical, like sanctus-bells.

Handwritten musical score for measures 59-73. The score is written on three staves: Treble, Treble, and Bass. The notation includes complex chords, dynamic markings (fff, f, mf, p, ppp, ff), and performance instructions like 'Ped' and 'a pre-echo.'

Measures 59-63: Treble staff has a chord of E-flat, B-flat, B-double-flat, and B-flat. Bass staff has a chord of B-flat, B-flat, B-flat, and B-flat. Dynamic marking: fff. Pedal marking: Ped.

Measures 64-68: Treble staff has a chord of B-flat, B-flat, B-flat, and B-flat. Bass staff has a chord of B-flat, B-flat, B-flat, and B-flat. Dynamic marking: f.

Measures 69-70: Treble staff has a chord of B-flat, B-flat, B-flat, and B-flat. Bass staff has a chord of B-flat, B-flat, B-flat, and B-flat. Dynamic marking: mf.

Measures 71-72: Treble staff has a chord of B-flat, B-flat, B-flat, and B-flat. Bass staff has a chord of B-flat, B-flat, B-flat, and B-flat. Dynamic marking: ff. Performance instruction: a 'pre-echo.'

Measure 73: Treble staff has a chord of B-flat, B-flat, B-flat, and B-flat. Bass staff has a chord of B-flat, B-flat, B-flat, and B-flat. Dynamic marking: ff.

Handwritten musical score for measures 73-86. The score is written on three staves: Treble, Bass, and Piano/Celesta. Measure numbers 73 through 86 are indicated above the staves. The Piano part (RH and LH) is marked with dynamics like *mf*, *f*, *mp*, *pp*, and *p*. The Celesta part is marked with *sfz* and *ecstatic!*. Performance instructions include "gong-like.", "As fast as possible!", and "a remote (and receding) tintinnabulation of chord-tones, somewhat obscure yet lyrical, like sanctus-bells." The score includes various musical notations such as chords, accidentals, and dynamic markings.

Handwritten musical score for measures 87-101. The score is written on three staves (treble, alto, and bass clefs). Measure numbers 87 through 101 are written above the staves. The music features various chords and single notes, with dynamic markings such as *mf*, *p*, *mp*, and *ppp*. A "Ped" (pedal) marking is present at the beginning of the system. The notation includes accidentals (sharps, flats, naturals) and rests.

Handwritten musical score for "The Great Silence" by John Cage, measures 32-44. The score is written on three staves (treble, middle, and bass clef) with various musical notations including notes, rests, and dynamic markings. Above the staves, measure numbers 32 through 44 are listed. The score includes handwritten annotations such as "mf↑", "ppp↓", "p poss.", "an echo, nearly inaudible.", "ppp", "sfz", "p almost inaudible.", and "p poss.". The piece concludes with a "Stop time-count." and a box containing a square symbol, followed by the text "... silence".

Handwritten musical score for piano, measures 1-12. The score includes three staves (bass, treble, and a lower bass staff) with various chords, dynamics (f, f poss., sfz), and performance instructions. A timeline at the top shows measure numbers 1 through 12. Annotations include 'cataclysmic!', 'Be poised for...', 'chromatic cluster', 'lift Ped gradually', 'sustain the chord manually; release the keys decisively', and 'release C#', 'release Bb'. A box labeled '6''' is in the upper left.

Handwritten musical score for piano, measures 12-26. The score is written on three staves (treble, middle, and bass clef). Measure 12 has a note in the middle staff with an annotation "release A4" and an arrow pointing to it. Measures 13-19 are mostly rests. Measure 20 has a complex chord in the top staff (F#4, G#4, A4, Bb4) and a note in the middle staff (Bb4). Measure 21 has a note in the top staff (Bb4) and a note in the middle staff (Bb4). Measure 22 has a note in the top staff (Bb4) and a note in the middle staff (Bb4). Measure 23 has a note in the top staff (Bb4) and a note in the middle staff (Bb4). Measure 24 has a note in the top staff (Bb4) and a note in the middle staff (Bb4). Measure 25 has a note in the top staff (Bb4) and a note in the middle staff (Bb4). Measure 26 has a note in the top staff (Bb4) and a note in the middle staff (Bb4). The score includes dynamic markings: ppp, f, f#, and mf. There are also annotations like "like Tubular Bells." and "Pedal".

16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35

stop time-count.

sustain B⁷ manually.

... silence

12"

begin time-count.

p poss.

f poss.

f poss.

Ped

Sost

Sost

Ped

1 2 3 4 5 6 7 8 9 10 11 12 13 14

brilliant: as fast and violent as possible.

stop time-count.

resume time-count.

subtle and dark: as if emerging out of the previous resonances.

p

p poss.

f poss.

f poss.

f poss.

Ped

Sost

Ped

14 15 16 17 18 19 20 21 22 23 24 25 26 27 28

serene.

p nearly inaudible.

p poss.

sffz

pt

delicate.

pp

pp

pp

Ped

18 19 30 31 32 33 34 35 36 37 stop time-count.

distant bells. pppp

8- [] 8- [] ... silence 20"

pppp p poss. an almost silent tinkle. Be poised for...

pppp echo: even more distant bells, on the horizon of audibility.

Ped. U.C.

As fast as possible: omphalic (of the Universal Axis, the "Navel of the Earth").
As soft as possible: infinitely fluid.

begin time-count. 0 1 2 3 4 5 6 stop time-count. 7

8- [] p poss. db almost inaudible. 8- [] sustain the chord manually; release the keys decisively. ... silence

p poss. p poss. release E^b

p poss. release G^b, A^b together release F^b

Ped. U.C. lift Ped gradually.

begin time-count. 0 1 2 3 4 5 6 7 8 9 10 11 12

16" = 1 second exactly.

Terrifying (in its inexorableness and symmetry): geometries of the Abyss!

Be poised for... p poss. p poss. p poss.

Ped. p poss.

A glittering ecstasy: unceasingly brilliant, like 'divine speech' (in an answer to prayer); infinitely radiant, luminous and bubbling; an avalanche of light!

Handwritten musical score for Percussion 1 and Percussion 2. The score is written on a grand staff with multiple staves for different percussion instruments. The time signature is 4/4, and the tempo is marked 'motor: medium vibrato'. The score includes various dynamic markings (f, ff, mf, dim, cresc, decresc) and articulation (accents, glissandi, glissandi). The score is divided into two main sections, Percussion 1 and Percussion 2, with a 'begin time-count' at the start. The score is written in a handwritten style with many annotations and performance instructions.

Percussion 1:

- BrDr Rin:** extremely aggressive glissandi, traversing all bars as rapidly as possible.
- Vib:** motor: medium vibrato.
- Ped:** f poss! Sfffz dim... f↑ cresc... ff sffz ff dim... mf↑

Percussion 2:

- ΔWC BrTW KBT:** absolutely violent! f poss! Sfffz ff↓ mf mf cresc... ff... f↑ dim... mf↑
- Alm:** f poss! f: f poss! fff f↑ fff Sfffz mf
- Sizz ChGym:** f poss. f: f poss! fff f↑ fff Sfffz mf

PERC 1

BrDr
Rin

Vib

Ped

ΔWC
BrTW
KBT

Alm

Sizz
ChCym

PERC 2

NB: all percussionists must coordinate attacks at the beginning of each bar (9" 11" 14" 17").

NB: all percussionists must coordinate attacks at the beginning of each bar (8", 1", 6", 14", 27"); allow all instruments to ring on indefinitely, but damp all resonances by 18" after the pianist's final high note.

PERCUSSION ZONE 1

"God the Father"

①

PERC 1

BrDr
Rin

Vib

Ped

ΔWC
BrTW
KBT

Alm

Sizz
ChCym

PERC 2

18 19 20 21 22 23 24 25 26 27

mf

mf

f dim...

mf

mf dim...

mp dim...

p...

f

f↓

mf

mf

mp

p↑...

p↑

p

mp↓

mp

PERC 1

BrDr
Rin

Vib

Ped

ΔWC
BrTW
KBT

Alm

Sizz
ChCym

PERC 2

27 28 29 30 31 32 33 34 35

mp↑

mp↓ dim...

p↓

Rin: cosmic.

p

p↑

p

mp

ppp↑ let resonate...

with Perc 4

pp↓ glossolalia.

with Perc 4

ppp↓ glossolalia.

mp...

mp↓...

p...

immediately 'half damp' ChCym, allowing some resonance...

p

mf

'behind' Perc 5 [Bass Drm]

let resonate...

PERCUSSION ZONE 1

"God the Father"

A glittering ecstasy: unceasingly brilliant, like 'divine speech' (in answer to prayer); infinitely radiant, luminous and bubbling; an avalanche of light!

begin time-count. = 1 second exactly.

PERC 3
Crot
Vib
Ped

extremely aggressive glissandi, traversing all bars as rapidly as possible.
motor: fast vibrato.

absolutely violent!

PERC 4
ΔWC
Coil
Sleigh
CBT
BrTW
BJB
BBW

PERC 3
Crot
Vib
Ped

PERC 4
ΔWC
Coil
Sleigh
CBT
BrTW
BJB
BBW

NB: all percussionists must coordinate attacks at the beginning of each bar (0", 1", 6", 14", 27");
allow all instruments to ring on indefinitely, but damp all resonances by 18" after the pianist's final high note.

PERCUSSION ZONE 2

"Jesus Christ, the Son of God"

18 19 20 21 22 23 24 25 26 27

PERC 3
Crot

Vib

ΔWC
Coil
Sleigh

CBT

BrTW
BJB
BBW

PERC 4

mf mf↓ mp dim... p p↑

f dim... mf mf↓ mp p↑

f f mf mf↓ mp p↑

27 28 29 30 31 32 33 34 35

PERC 3
Crot

Vib

ΔWC
Coil
Sleigh

CBT

BrTW
BJB
BBW

PERC 4

Vib: gentle, distant, dreamy.

Crot: poetic, starry.

let resonate...

ppp↑... ppp↑... ppp↓ glossolalial. ppp↓ glossolalial. let resonate...

with Perc 2

with Perc 2

f poss! BJB: agitate the strings so that the bronze bells 'murmur' as continuously as possible: glossolalial.

PERCUSSION ZONE 2

"Jesus Christ, the Son of God"

2

A glittering ecstasy: unceasingly brilliant, like 'divine speech' (in answer to prayer); infinitely radiant, luminous and bubbling; an avalanche of light!

begin time-count. = 1 second exactly.

PERC 5 Glock

BrDr Coil ΔWC T-T Gongs PERC 6

extremely aggressive glissandi, traversing all bars as rapidly as possible.

absolutely violent! f poss!

off-centre f poss! stinging attacks.

dim... sfzz dim... sfzz dim... ff sfzz sfzz dim... mf↑

mf↑ dim... mf cresc... mf mp f sfz

sfz mf sfz mf mp f sfz

take ; to BD...

take

BD: • = 160 b.p.m. for ten attacks, clearly articulated - a resonant 'heartbeat'.

let resonate...

mf mp mp dim... p cresc... mf: sfz

mp mp

rub the surface continuously...

f poss! groan-like, glossolalial.

let resonate...

NB: all percussionists must coordinate attacks at the beginning of each bar (0", 1", 6", 14", 27"); allow all instruments to ring on indefinitely, but damp all resonances by 18" after the pianist's final high note.

PERCUSSION ZONE 3 'The Holy Spirit'

CHAPTER 7. THE MANDALIKONS: 'COMPROVISATION' AND FREEDOM WITH PERMUTATIONS, PRECESSION, AND PROPORTIONAL STRATEGIES

7.1 ZODIAC: CRYSTAL ORBIT IMPROVISATIONS

7.1.1 FURTHER ANALYTICAL NOTES

Apart from the soprano recorder's twelve volatile $\langle \alpha \rangle$ sonorities (which were chosen and ordered with the criterion of *maximizing variety* in mind – and according to their ability to make a smooth transition into the pitch-classes of the recorder's $\langle \beta \rangle$ material), pitch-organization throughout **Zodiac: Crystal Orbit Improvisations** has been fully explicated towards the end of section 1.2.1. Likewise, this comprovisation's randomized parameters were covered within section 1.2.7; and its cue-regulated flexible formal structure, including its textural development, have already been discussed in section 1.2.8.

Essentially, then, all that remains to be revealed concerning **Zodiac: Crystal Orbit Improvisations** is a 'virtual' harmonic edifice that lies hidden within the voice-data of the MIDI wind instrument's sound-source when it consists of the twelve Yamaha DX7 'voices' created by me; these Frequency-Modulated Yamaha DX7 'voice'-timbres have, however, been employed for every one of **Zodiac's** Australian performances to date.

Like Anton Webern's symmetrical fixed-register chords, or indeed like the dulcet tones of a metal windchime, this harmonic structure behind **Zodiac: Crystal Orbit Improvisations** is 'virtual' in that – although it was originally conceived as a rather 'Shanahanian' harmonic entity – its pitches are never all sounded together, simultaneously, as a true chord. These synthesizer pitches emerge from prominent immobile frequencies that were each assigned to operator 1 within the various Yamaha DX7 'voices' available to the MIDI wind instrument (which, during a live performance, are selected randomly *in succession*). Note that because these pitches are all products of carrier-frequencies that stay forever fixed, unlike their variable modulator-frequencies within the Yamaha DX7 FM 'algorithm', the c:m frequency ratios (and so the voices' timbres) will change, depending upon which note is played by the MIDI wind instrument; whenever one instigates a portamento with such Yamaha DX7 'voices', a striking gestalt of timbral warping and pitch-sliding therefore occurs.

It must be remembered, nevertheless, that the following 'virtual harmony' is by no

means connected inextricably to **Zodiac: Crystal Orbit Improvisations**, since none of my twenty-four Yamaha DX7 synthesizer sounds (every one of whose parametric details have been appended to the Performance Notes) are actually mandatory: and yet I have described, within the Performance Notes and below, certain vital attributes of the electroacoustic timbres that can be utilized for **Zodiac** – but only in general terms. Perhaps such an open approach to sound-colour renders this harmony doubly ‘virtual’?

THE MIDI WIND INSTRUMENT’S OPTIONAL SOUND-SOURCE’S INTERNAL PITCH-DATA

| Yamaha DX7 Voice Name | Operator 1
Fixed Frequency | Corresponding Pitch |
|-----------------------|-------------------------------|---------------------|
| IS Vox e \flat | 616.6 Hz | ≈ E \flat 3 |
| IS SineVox | — | — |
| IS JF Vox | — | — |
| IS Vox 1 | 109.6 Hz | ≈ A \natural 1 |
| IS Vox 2 | 134.9 Hz | ≈ C \sharp 2 |
| IS Vox 3 | 204.2 Hz | ≈ G \sharp 2 |
| IS Vox 4 | 371.5 Hz | ≈ F \sharp 3 |
| IS Vox 5 | 575.4 Hz | ≈ D \flat 4 |
| IS Vox 6 | 707.9 Hz | ≈ F \flat 4 |
| IS Vox 7 | 1096.0 Hz | ≈ C \sharp 5 |
| IS Vox 8 | 1549.0 Hz | ≈ G \flat 5 |
| IS Vox 9 | 2089.0 Hz | ≈ C \flat 5 |

Within the Performance Notes to **Zodiac: Crystal Orbit Improvisations** (p.iii), I have stated that the “twelve voices of the MIDI wind instrument’s sound-source must all give rise to sustainable, dynamic, quasi-vocal sounds: ethereal, other-worldly, disembodied, Siren-like, divine, surreal...” and that the “twelve keyboard synthesizer voices should all be bell-like or (quasi-)metallic in timbre – yet spanning quite a wide range of colours and envelopes”. Whilst the keyboard synthesizer’s timbral palette merely reflects my own sonoric tastes (but – having bell-like or metallic sound-signatures – nonetheless symbolizes things sacred), in the case of the MIDI wind instrument, its sounds’ sustained ‘hypervocality’ is intended to be both a foil to the soprano recorder’s expressive human-voice-like quality and a representation of beings metaphysical: so, those immovable tones tabulated above could even be thought of as the vocal formants of a divinity!

Ian Shanahan (1996)

– *To Kala Perkins*

For Roger Dean and Sandy Evans to play with me:

~~~~~

# *Zodiac*

## *Crystal Orbit Improvisations*

a mandalikon

for

amplified soprano recorder,

MIDI wind instrument, keyboard synthesizer,

and

*optional* real-time interactive computer control

~~~~~

PROGRAMME ANNOTATION

Zodiac: Crystal Orbit Improvisations

a mandalikon

for amplified soprano recorder, MIDI wind instrument,
keyboard synthesizer, and optional real-time computer control

Ian Shanahan (1996)

Given my ongoing philosophical reflections on the Cosmos – and the fact that the recorder-player has twelve ‘modules’ of material to cycle through herein – is it not surprising that I have named this piece (or, perhaps more accurately, this ‘comprovisation’: a compositional framework for improvisation) **Zodiac**?

When one ponders the mechanics of nature at various levels, it soon becomes apparent that much unfolds *epicyclically* – as ‘wheels-within-wheels’ – and that the universe is essentially devoid of linearity (whilst exhibiting, nonetheless, some degree of architectonic self-similarity). Moreover, the magnitude of ‘stellar time’ when compared with the infinitesimal brevity of a human life-span, absolutely staggers me: consider that between one’s first observation of the night-sky and one’s final glimpse of it just before death, the star-configurations (and astronomical cycles) do appear to remain invariant. Therefore, I desired to create a work which would provoke diverse music-making and spontaneous invention within an utterly non-teleological ‘crystalline’ colotomic structure, without any clear-cut climaxes or obvious points of repose: **Zodiac: Crystal Orbit Improvisations** simply starts and, some time later, stops! So, each player (improvising within certain specified parameters) ‘orbits’ through their respective musical source-materials, which are themselves internally organized and permuted algebraically according to the mathematics of Cyclic Groups – i.e. orbits within orbits... The MIDI wind instrumentalist and the synthesizer player also cue each other to pause and resume locally; the recorder-player signals only the end of the performance. A stream of autonomous computer data, or instead pitch-data from both wind instruments, triggers real-time interactive software (such as a MAX patch) to randomly change the synthesizers’ voices: I envisage the overall timbral effect to be rather like sunlight being dispersed through a rotating multifaceted crystal and refracted unpredictably – dazzling, flickering, brilliantly coruscative!

Such circumfluent epicyclicity, all-pervasive here (from the music’s microscopic sound-atoms through to its macro-organization), I believe invites one to *contemplate* upon its relentless acoustical ‘ever-nowness’, moment-by-moment – hence my categorial neologism for **Zodiac**: a “mandalikon”. And **Zodiac**’s titular ‘crystal orbits’ allude both to this work’s frozen permutative algebra and to celestial mechanics in general – including the fanciful poetic cosmology of the pre-Socratic philosopher Anaximenes of Miletus (fl. ca.545 BC), who imagined the stars to be ornaments attached to a crystal sphere that revolved around the Earth.

Zodiac: Crystal Orbit Improvisations, commissioned by Roger Dean and *austraLYSIS*, is joyfully dedicated to my friend and colleague Kala Perkins, an astronomer-artist-cosmologist ... a lover of stars who is researching the interface between astronomy, religion, and music: three aspects of the same thing (a *quadrivium*), in my book.

Zodiac: Crystal Orbit Improvisations was premièred by Ian Shanahan (amplified soprano recorder), Sandy Evans (Yamaha WX11 MIDI wind instrument), Roger Dean (Yamaha DX7 keyboard synthesizer), and MAX software, during an *austraLYSIS* concert held at The Performance Space, 199 Cleveland Street, Redfern, Sydney, on 20 July 1996.

A recording of **Zodiac: Crystal Orbit Improvisations**, played by the same personnel, is now commercially available on the Compact Discs “Auburn Splendour” (Broad Music Records Jade JAD CD 1092) and “Harmonia” (SIDEREAL Records SRCD01).

PERFORMANCE NOTES

THE IMPROVISATORY STRUCTURE

a) Soprano Recorder

The soprano recorder part consists of twelve 'modules', all of them commencing with a brief *optional* pause prior to a single sustained volatile 'fractalous' sonority (the <α> material) – such unstable objects should sometimes last almost a whole breath-length! – which then merges into pitch-material that forms the basis for improvisation (the <β> material). Within each of these modules, this <β> pitch-material is 'repeated', orbit-like, until the recorder-player is cued, *by both of the other instruments falling silent*, to move immediately on to the next module (regardless of whether a module's pitch-material has been completed). After the conclusion of the twelfth module, the process starts all over again with the initial module. This (epi)cyclic piece finishes when the recorder-player signals the other instrumentalists to stop, after which the next module is moved to as before, but being played without any accompaniment. (The final module's pitch-material is interpreted or 'read through' just once.) **Zodiac: Crystal Orbit Improvisations** must not end before the completion of at least one 'cycle' of twelve modules.

Interpretative and Formal Possibilities

- i. Within the <β> pitch-material of each module, subsets of pitches can be looped 'epicyclically': as one encounters a smaller internal subset of adjacent pitches, it too can be looped (cyclically, or even permutatively!).
- ii. An interpretative possibility: within each module, the initial presentation (only) of the <β> pitch-material might just be a relatively straightforward or simple reading-through of the given pitches, with little or no embellishment.
- iii. Rather than commencing the piece at the beginning of module 1, the recorder-player may choose another starting-point elsewhere – either with another <α> sonority, or somewhere within a module's <β> pitch-material. It is desirable in this case, however, that the other players also begin at a roughly equivalent spot in their own parts – i.e. at approximately the same percentage of the way through their given pitch-materials.
- iv. When the MIDI wind instrument's sound-source and the keyboard synthesizer both fall silent together, the recorder-player might *occasionally* elect to continue orbiting through their current module's <β> pitch-material (instead of immediately proceeding to the next module, as described above). Such a choice of continuation within the same module ought to be exercised *no more than 25% of the time* in response to quiescence from both of the other instruments.

b) MIDI Wind Instrument and Keyboard Synthesizer

Both players are given a one-page single block of pitch-material – derived from the <β> pitch-materials of the soprano recorder part – upon which to improvise; these are 'orbited through' just like the soprano recorder part's twelve modules, until the recorder-player communicates the signal to stop, just before the end of the piece. Within this framework, however, *silences of indeterminate duration* are to be randomly interjected as follows:

- i. The MIDI wind instrumentalist (while playing on) cues the synthesizer-player to stop then to resume at the point of interruption of their pitch-material.
- ii. The synthesizer-player likewise signals the silence of the MIDI wind instrument, as well as its re-entry at the same place within its pitch-material.
- iii. The synthesizer-player also cues the synchronous silences of both the keyboard

~ i ~

synthesizer and the MIDI wind instrument (these silent hiatuses serving to trigger the recorder-player's progress through their 'zodiacal modules'), and the resumption of both instruments from the same location within their respective pitch-materials.

c) Optional Real-Time Interactive Computer Control

Using the appropriate computer hardware and software, a control program (or 'patch') must be created to function as follows:

- i. At random intervals, the soprano recorder's and MIDI wind instrument's pitch-data is evaluated thence converted into streams of MIDI-data. This MIDI-data then triggers random sequences of voice-changes in both the keyboard synthesizer and in the MIDI wind instrument's sound-source. (Should such an interactive patch prove to be unfeasible or problematic in practice, then the interactivity may be scrapped, so that the streams of MIDI-data may instead be generated wholly autonomously by the computer that is running the control program.)
- ii. For musically satisfying results, however, not all of these random voice-changes should be rapid: although a kaleidoscopic succession of timbres is desired, certain colours ought to be allowed to remain present for an appreciable duration.
- iii. Moreover, it is imperative that these random voice-changes *do not cut off the sound suddenly*: fresh voices on both the keyboard synthesizer and on the MIDI wind instrument's sound-source should not initially be silent, but instead should continue and sustain just as the previous voices would have, preferably from an analogous point in their envelopes (or even from the beginning of the 'release' portion of their envelopes, where necessary). One possible method of attaining such 'after-resonances' might be to switch MIDI channels at each voice-change.

Although the participation of such real-time (interactive) computer control is obviously preferred, it is *not* mandatory: *if this sort of technology is unavailable, then the synthesizer-player and the MIDI wind instrumentalist – or, better still, two assistants – must effect the random voice-changes manually.*

Note: at the beginning of **Zodiac: Crystal Orbit Improvisations**, all instruments do normally start together. (Alternatively, the MIDI wind instrumentalist and the synthesizer-player might commence only after the soprano recorder's first <α> 'fractal' sonority has been completed.)

THE INSTRUMENTS AND THEIR VOICES

a) Soprano Recorder

Note: the soprano recorder will need to be amplified in concert; excessive sound-reinforcement is, however, to be avoided. Optimally, the loudspeaker(s) for the soprano recorder should be positioned near the recorder-player, so as to create the impression of a single sound-source for this instrument.

Research into the fingering-configurations that yield the twelve 'fractalous' soprano recorder <α> sonorities herein was carried out upon an ebony Moeck Rottenburgh soprano recorder. On any other models of soprano recorder however, different (microtonal) pitches will probably be produced; if these pitch-discrepancies are indeed small, then they can be safely ignored. In some circumstances nonetheless, it might prove beneficial to modify some of the given fingerings accordingly.

All pitches within these twelve flickering 'fractalous' <α> entities are notated in terms of equal-tempered quartertones, using the standard symbology:

♯ and ♭ denote a *quartertone above* ♮, and a *quartertone below* ♮, respectively.

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Smaller micro-inflections (up to about an eighthtone) are denoted by arrowheads affixed to accidentals.

Note: further details concerning the production and interpretation of the soprano recorder's <α> material will be provided below, under "Randomized Parameters".

b) MIDI Wind Instrument and Keyboard Synthesizer

Note: the MIDI wind instrument's part is written within the regular range of the *saxophone* – since its player is likely to be a single-reed specialist. Should a MIDI wind instrument(alist) happen to be unavailable, a keyboard synthesizer or some other type of MIDI musical instrument may instead play its part.

In order to maximize flexibility of musical result, as well as for obvious pragmatic reasons, I have deliberately avoided the specification of particular models of electronic or electroacoustic instruments. Nevertheless, **Zodiac: Crystal Orbit Improvisations** was conceived with definite classes of synthesized *timbre* in mind, so that certain general points can be made:

- i. Both instruments must utilize *exactly* twelve distinct voices each!
- ii. The twelve voices of the MIDI wind instrument's sound-source must all give rise to sustainable, dynamic, quasi-vocal sounds: ethereal, other-worldly, disembodied, Siren-like, divine, surreal...
- iii. *It is essential that both the MIDI wind instrument and its sound-source possess portamento capabilities.* The portamento on the MIDI wind instrument's sound-source will need to be regulated by an assistant, by the MIDI wind instrumentalist themselves (optimally), by the synthesizer-player – or even externally, by computer.
- iv. The twelve keyboard synthesizer voices should all be bell-like or (quasi-)metallic in timbre – yet spanning quite a wide range of colours and envelopes. Microtonal keyboard settings may also be activated.
- v. Concerning equipment requirements, the keyboard synthesizer must have both a *foot switch pedal* (i.e. a 'sustain pedal', for *sustain on/off*) and a *foot controller pedal* (i.e. a 'volume pedal', for varying the *volume*) connected to it. Similarly, a foot pedal might need to be connected to the MIDI wind instrument's sound-source, as a portamento controller.

For **Zodiac: Crystal Orbit Improvisations'** world première performance, two Yamaha DX7 synthesizers were employed, one of which – a Yamaha DX7 Series I – was the sound-source for a Yamaha WX Series MIDI wind instrument. (All twenty-four Yamaha DX7 voices were created by the composer; the parametric data for each of these voices is appended to these Performance Notes.)

c) Optional Real-Time Interactive Computer Control

A software package such as MAX (running on an Apple Macintosh or IBM-compatible computer system) is ideal for **Zodiac: Crystal Orbit Improvisations:** an original MAX patch was devised by Roger Dean for the work's first performance; this MAX patch can be made available upon request. (My e-mail address is given below.)

RANDOMIZED PARAMETERS

Within each of the three instrumental parts which comprise **Zodiac: Crystal Orbit Improvisations**, a number of technical/musical parameters are bracketed thus: *Rand { }*. All of these bracketed parameters may be randomly transformed, introduced, or eliminated in performance. As such, they provide an improvisational stimulus to the players while framing the artistic boundaries within which the music can unfurl. My aim is simply to

provoke diverse musicality and spontaneous invention within a completely non-teleological crystalline colotomic structure. The randomized parameters, listed in the order in which they appear within each part, are:

a) Soprano Recorder

<α> Randomize: {alternations between *fluttersong* and *tongue-tremolo*; normal articulations (e.g. staccato, portato, legato); "breath trills" (i.e. pitch-oscillations and -fluctuations generated through breath-control, without any finger-movement whatsoever!); air-flow (such that the given pitches are elicited)}

Optional, for the *twelfth* <α> *sonority only*: also Randomize: {glissandi (in both directions) of various ranges between the given pitch-limits, using just the right-hand little finger (as shown by the accompanying tablature pictograph)}

Note: for each <α> sonority, all pitches between orthogonal brackets [] manifest themselves as distinct vibrational modes of a *single fingering*: hence, no finger-movement whatsoever should take place prior to progressing on to the <β> material! However, as a direct outcome of engaging the <α> randomized parameters given above, compel these bracketed pitches to 'crack' upwards or downwards, flickering chaotically between and through several vibrational modes and multiphonic component tones. The overall impression of the coruscative <α> objects should therefore be one of *volatile instability* – a locally unpredictable 'acoustic fractal', which may be sustained for almost an entire breath-length.

<β> Randomize: {(multi)octave transpositions; the addition of unspecified material; the (s) pacing of events (i.e. their speed and density); the insertion of *silences*; articulations (*sputato* [i.e. a noisy, exaggerated, overblown attack], *tongue-tremolo*, *fluttersong*, normal articulations [e.g. staccato, portato, legato], etc.); microtonal pitches; glissandi; vibrato (of various types); air-flow; multiphonics; the admixture and withdrawal of vocalized sounds; air-noises}

Note: for *tongue-tremolo*, articulate, *as quickly and as evenly as possible*, the (double-tonguing) phonemes '[d]idl(d)idl(d)idl...' – as in "middle" – or the much more common (double-tonguing) pattern '[t]eketeki...' ('[d]egegede...'). The type and intensity of the tongue-tremolo to be employed at each occurrence is left to the discretion of the recorder-player.

b) MIDI Wind Instrument

Randomize: {(multi)octave transpositions; the addition of unspecified material; the (s) pacing of events (i.e. their speed and density); articulations (*fluttersong*, normal articulations [e.g. staccato, portato, legato], etc.); microtonal pitches; portamento; pitch-bends; vibrato (of various types); air-flow}

c) Keyboard Synthesizer

Randomize: {(multi)octave transpositions; the addition of unspecified material; the (s) pacing of events (i.e. their speed and density); textures (e.g. single tones, chords, grace-note groups, arpeggiation, tremoli...); durations of key-depression; key-velocities; the depression and release of the sustaining pedal; the pressing down and lifting up of the volume pedal; manipulations of the pitch-wheel; the activation, transformation, and neutralization of microtonal keyboard settings (i.e. equal-tempered microtones, or unequal [historical] temperaments)}

Note: the randomization of *portamento* is optional.

VOICE DATA for the MIDI WIND INSTRUMENT'S SOUND-SOURCE, as used in the World Première Performance:

Yamaha DX7 (Series I)

VOICE NAME: *IS Vox e^b*

Created by: Ian Shanahan

Algorithm: 28

Feedback: 0

Key Transpose: C3

Pitch Modulation Sensitivity: 1

Oscillator Synchronization: On

| LFO: Wave | Speed | Delay | PMD | AMD | Sync |
|-----------|-------|-------|-----|-----|------|
| Sine | 06 | 77 | 12 | 99 | On |

| | Operator 1 | Operator 2 | Operator 3 | Operator 4 | Operator 5 | Operator 6 |
|--------------------------|------------|------------|------------|------------|------------|------------|
| Ampl. Mod. Sens.: | 0 | 0 | 0 | 0 | 0 | 3 |
| Mode: | Fixed Hz | Ratio | Ratio | Fixed Hz | Fixed Hz | Ratio |
| Frequency: | 616.6 | 01.00 | 01.00 | 2.291 | 1.349 | 01.00 |
| Detune: | +7 | -1 | +0 | +0 | +1 | -3 |
| EG Rate 1: | 30 | 92 | 30 | 30 | 92 | 30 |
| EG Rate 2: | 21 | 00 | 00 | 24 | 00 | 00 |
| EG Rate 3: | 00 | 00 | 05 | 10 | 00 | 05 |
| EG Rate 4: | 28 | 28 | 28 | 28 | 28 | 28 |
| EG Level 1: | 99 | 99 | 99 | 99 | 99 | 99 |
| EG Level 2: | 72 | 99 | 99 | 76 | 99 | 99 |
| EG Level 3: | 00 | 83 | 77 | 00 | 99 | 77 |
| EG Level 4: | 00 | 00 | 00 | 00 | 00 | 00 |

Keyboard Level Scaling

| | | | | | | |
|---------------------------|------|------|------|------|------|------|
| Break Pt.: | A-1 | A-1 | A-1 | C3 | A-1 | A-1 |
| Curve L: | -LIN | -LIN | -LIN | -LIN | -LIN | -LIN |
| Curve R: | -LIN | -LIN | -LIN | +LIN | -LIN | -LIN |
| Depth L: | 00 | 00 | 00 | 20 | 00 | 00 |
| Depth R: | 00 | 00 | 00 | 08 | 00 | 00 |
| Kbd. Rate Scaling: | 0 | 0 | 0 | 0 | 0 | 0 |
| Op. Outpt. Level: | 87 | 78 | 80 | 81 | 83 | 75 |
| K. Velocity Sens.: | 3 | 3 | 0 | 0 | 0 | 0 |

Pitch EG

| | |
|-------------------|--------------------|
| Rate 1: 99 | Level 1: 50 |
| Rate 2: 99 | Level 2: 50 |
| Rate 3: 99 | Level 3: 50 |
| Rate 4: 99 | Level 4: 50 |

Poly/Mono: Poly

| | | |
|--------------------|---------------|-------------|
| Pitch Bend: | Range | Step |
| | 06 [maximum!] | 00 |

| | | | |
|--------------------|------------------|------------------|--------------------|
| Portamento: | Mode | Glissando | Time |
| | Sus-Key P Retain | Off | 00 - 99 [variable] |

| | Range | Pitch | Amplitude | EG Bias |
|--------------------------|-------|-------|-----------|---------|
| Modulation Wheel: | 00 | Off | Off | Off |
| Foot Control: | 00 | Off | Off | Off |
| Breath Control: | 60 | On | On | On |
| Aftertouch: | 00 | Off | Off | Off |

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VOICE DATA for the MIDI WIND INSTRUMENT'S SOUND-SOURCE, as used in the World Première Performance:

Yamaha DX7 (Series I)

VOICE NAME: *IS SineVox*

Created by: Ian Shanahan

Algorithm: 28

Feedback: 0

Key Transpose: C3

Pitch Modulation Sensitivity: 1

Oscillator Synchronization: On

| LFO: Wave | Speed | Delay | PMD | AMD | Sync |
|-----------|-------|-------|-----|-----|------|
| Sine | 06 | 77 | 12 | 99 | On |

| | Operator 1 | Operator 2 | Operator 3 | Operator 4 | Operator 5 | Operator 6 |
|--------------------------|------------|------------|------------|------------|------------|------------|
| Ampl. Mod. Sens.: | 0 | 0 | 0 | 0 | 0 | 3 |
| Mode: | Ratio | Ratio | Ratio | Fixed Hz | Fixed Hz | Ratio |
| Frequency: | 01.00 | 01.00 | 01.00 | 2.291 | 1.349 | 01.00 |
| Detune: | +0 | -1 | +0 | +0 | +1 | -3 |
| EG Rate 1: | 30 | 11 | 30 | 30 | 92 | 30 |
| EG Rate 2: | 21 | 13 | 00 | 24 | 00 | 00 |
| EG Rate 3: | 00 | 18 | 05 | 10 | 00 | 05 |
| EG Rate 4: | 28 | 28 | 28 | 28 | 28 | 28 |
| EG Level 1: | 99 | 99 | 99 | 99 | 99 | 99 |
| EG Level 2: | 72 | 77 | 99 | 76 | 99 | 99 |
| EG Level 3: | 00 | 73 | 77 | 00 | 99 | 77 |
| EG Level 4: | 00 | 00 | 00 | 00 | 00 | 00 |

Keyboard Level Scaling

| | | | | | | |
|---------------------------|------|------|------|------|------|------|
| Break Pt.: | A-1 | D #3 | A-1 | C3 | A-1 | A-1 |
| Curve L: | -LIN | -LIN | -LIN | -LIN | -LIN | -LIN |
| Curve R: | -LIN | -LIN | -LIN | +LIN | -LIN | -LIN |
| Depth L: | 00 | 00 | 00 | 20 | 00 | 00 |
| Depth R: | 00 | 19 | 00 | 08 | 00 | 00 |
| Kbd. Rate Scaling: | 0 | 0 | 0 | 0 | 0 | 0 |
| Op. Outpt. Level: | 87 | 81 | 80 | 81 | 83 | 75 |
| K. Velocity Sens.: | 3 | 3 | 0 | 0 | 0 | 0 |

Pitch EG

| | |
|-------------------|--------------------|
| Rate 1: 99 | Level 1: 50 |
| Rate 2: 99 | Level 2: 50 |
| Rate 3: 99 | Level 3: 50 |
| Rate 4: 99 | Level 4: 50 |

Poly/Mono: Poly

| | | |
|--------------------|---------------|-------------|
| Pitch Bend: | Range | Step |
| | 06 [maximum!] | 00 |

| | | | |
|--------------------|------------------|------------------|--------------------|
| Portamento: | Mode | Glissando | Time |
| | Sus-Key P Retain | Off | 00 - 99 [variable] |

| | Range | Pitch | Amplitude | EG Bias |
|--------------------------|-------|-------|-----------|---------|
| Modulation Wheel: | 00 | Off | Off | Off |
| Foot Control: | 00 | Off | Off | Off |
| Breath Control: | 60 | On | On | On |
| Aftertouch: | 00 | Off | Off | Off |

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VOICE DATA for the MIDI WIND INSTRUMENT'S SOUND-SOURCE, as used in the World Première Performance:

Yamaha DX7 (Series I)

VOICE NAME: *IS JF Vox* **Created by:** Dr Jim Franklin; varied by Ian Shanahan

Algorithm: 03 **Feedback:** 0 **Key Transpose:** A # 3

Pitch Modulation Sensitivity: 1 **Oscillator Synchronization:** Off

| LFO: Wave | Speed | Delay | PMD | AMD | Sync |
|-----------|-------|-------|-----|-----|------|
| Sine | 15 | 00 | 18 | 00 | On |

| | Operator 1 | Operator 2 | Operator 3 | Operator 4 | Operator 5 | Operator 6 |
|--------------------------|------------|------------|------------|------------|------------|------------|
| Ampl. Mod. Sens.: | 0 | 0 | 2 | 0 | 0 | 2 |
| Mode: | Fixed Hz | Fixed Hz | Ratio | Fixed Hz | Fixed Hz | Ratio |
| Frequency: | 4.571 | 3.090 | 00.56 | 3.162 | 2.455 | 00.57 |
| Detune: | +0 | -4 | -2 | +0 | +0 | +7 |
| EG Rate 1: | 30 | 92 | 60 | 30 | 92 | 60 |
| EG Rate 2: | 30 | 31 | 17 | 30 | 31 | 17 |
| EG Rate 3: | 25 | 25 | 99 | 25 | 25 | 99 |
| EG Rate 4: | 30 | 27 | 24 | 30 | 27 | 24 |
| EG Level 1: | 99 | 99 | 99 | 99 | 99 | 99 |
| EG Level 2: | 00 | 99 | 99 | 00 | 99 | 99 |
| EG Level 3: | 00 | 99 | 99 | 00 | 99 | 99 |
| EG Level 4: | 00 | 99 | 90 | 00 | 99 | 90 |

Keyboard Level Scaling

| | | | | | | |
|---------------------------|------|------|------|------|------|------|
| Break Pt.: | A-1 | A-1 | A-1 | A-1 | A-1 | A-1 |
| Curve L: | -LIN | -LIN | -LIN | -LIN | -LIN | -LIN |
| Curve R: | -LIN | -LIN | -LIN | -LIN | -LIN | -LIN |
| Depth L: | 00 | 00 | 00 | 00 | 00 | 00 |
| Depth R: | 00 | 00 | 00 | 00 | 00 | 00 |
| Kbd. Rate Scaling: | 0 | 0 | 0 | 0 | 0 | 0 |
| Op. Outpt. Level: | 83 | 65 | 87 | 83 | 65 | 87 |
| K. Velocity Sens.: | 3 | 3 | 0 | 0 | 0 | 0 |

Pitch EG

| | |
|-------------------|--------------------|
| Rate 1: 99 | Level 1: 50 |
| Rate 2: 99 | Level 2: 50 |
| Rate 3: 99 | Level 3: 50 |
| Rate 4: 99 | Level 4: 50 |

Poly/Mono: Poly

| | | |
|--------------------|---------------|-------------|
| Pitch Bend: | Range | Step |
| | 06 [maximum!] | 00 |

| | | | |
|--------------------|------------------|------------------|--------------------|
| Portamento: | Mode | Glissando | Time |
| | Sus-Key P Retain | Off | 00 – 99 [variable] |

| | Range | Pitch | Amplitude | EG Bias |
|--------------------------|-------|-------|-----------|---------|
| Modulation Wheel: | 99 | Off | Off | On |
| Foot Control: | 00 | Off | Off | Off |
| Breath Control: | 60 | On | On | On |
| Aftertouch: | 00 | Off | Off | Off |

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VOICE DATA for the MIDI WIND INSTRUMENT'S SOUND-SOURCE, as used in the World Première Performance:

Yamaha DX7 (Series I)

VOICE NAME: *IS Vox 1* **Created by:** Ian Shanahan

Algorithm: 28 **Feedback:** 0 **Key Transpose:** C3

Pitch Modulation Sensitivity: 1 **Oscillator Synchronization:** On

| LFO: Wave | Speed | Delay | PMD | AMD | Sync |
|-----------|-------|-------|-----|-----|------|
| Sine | 06 | 51 | 12 | 99 | On |

| | Operator 1 | Operator 2 | Operator 3 | Operator 4 | Operator 5 | Operator 6 |
|--------------------------|------------|------------|------------|------------|------------|------------|
| Ampl. Mod. Sens.: | 0 | 0 | 0 | 0 | 0 | 3 |
| Mode: | Fixed Hz | Ratio | Ratio | Fixed Hz | Fixed Hz | Ratio |
| Frequency: | 109.6 | 01.00 | 01.00 | 2.042 | 2.512 | 01.00 |
| Detune: | +3 | +0 | +0 | +0 | +0 | -2 |
| EG Rate 1: | 30 | 92 | 30 | 30 | 92 | 30 |
| EG Rate 2: | 21 | 00 | 00 | 24 | 00 | 00 |
| EG Rate 3: | 00 | 00 | 05 | 10 | 00 | 05 |
| EG Rate 4: | 28 | 28 | 28 | 28 | 28 | 28 |
| EG Level 1: | 99 | 99 | 99 | 99 | 99 | 99 |
| EG Level 2: | 72 | 99 | 99 | 76 | 99 | 99 |
| EG Level 3: | 00 | 83 | 77 | 00 | 99 | 77 |
| EG Level 4: | 00 | 00 | 00 | 00 | 00 | 00 |

Keyboard Level Scaling

| | | | | | | |
|---------------------------|------|------|------|------|------|------|
| Break Pt.: | A-1 | A-1 | A-1 | C3 | A-1 | A-1 |
| Curve L: | -LIN | -LIN | -LIN | -LIN | -LIN | -LIN |
| Curve R: | -LIN | -LIN | -LIN | +LIN | -LIN | -LIN |
| Depth L: | 00 | 00 | 00 | 20 | 00 | 00 |
| Depth R: | 00 | 00 | 00 | 08 | 00 | 00 |
| Kbd. Rate Scaling: | 0 | 0 | 0 | 0 | 0 | 0 |
| Op. Outpt. Level: | 87 | 78 | 79 | 81 | 83 | 75 |
| K. Velocity Sens.: | 3 | 3 | 0 | 0 | 0 | 0 |

Pitch EG

| | |
|-------------------|--------------------|
| Rate 1: 99 | Level 1: 50 |
| Rate 2: 99 | Level 2: 50 |
| Rate 3: 99 | Level 3: 50 |
| Rate 4: 99 | Level 4: 50 |

Poly/Mono: Poly

| | | |
|--------------------|---------------|-------------|
| Pitch Bend: | Range | Step |
| | 06 [maximum!] | 00 |

| | | | |
|--------------------|------------------|------------------|--------------------|
| Portamento: | Mode | Glissando | Time |
| | Sus-Key P Retain | Off | 00 – 99 [variable] |

| | Range | Pitch | Amplitude | EG Bias |
|--------------------------|-------|-------|-----------|---------|
| Modulation Wheel: | 00 | Off | Off | Off |
| Foot Control: | 00 | Off | Off | Off |
| Breath Control: | 60 | On | On | On |
| Aftertouch: | 00 | Off | Off | Off |

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VOICE DATA for the MIDI WIND INSTRUMENT'S SOUND-SOURCE, as used in the World Première Performance:

Yamaha DX7 (Series I)

VOICE NAME: /S Vox 2

Created by: Ian Shanahan

Algorithm: 28

Feedback: 0

Key Transpose: C3

Pitch Modulation Sensitivity: 1

Oscillator Synchronization: On

| LFO: Wave | Speed | Delay | PMD | AMD | Sync |
|-----------|-------|-------|-----|-----|------|
| Sine | 04 | 84 | 17 | 99 | On |

| | Operator 1 | Operator 2 | Operator 3 | Operator 4 | Operator 5 | Operator 6 |
|--------------------------|------------|------------|------------|------------|------------|------------|
| Ampl. Mod. Sens.: | 0 | 0 | 0 | 0 | 0 | 3 |
| Mode: | Fixed Hz | Ratio | Ratio | Fixed Hz | Fixed Hz | Ratio |
| Frequency: | 134.9 | 01.00 | 01.00 | 1.023 | 4.074 | 01.00 |
| Detune: | -6 | -2 | +0 | +1 | -7 | +5 |
| EG Rate 1: | 30 | 92 | 30 | 30 | 92 | 30 |
| EG Rate 2: | 21 | 00 | 00 | 24 | 00 | 00 |
| EG Rate 3: | 00 | 00 | 05 | 10 | 00 | 05 |
| EG Rate 4: | 28 | 28 | 28 | 28 | 28 | 28 |
| EG Level 1: | 99 | 99 | 99 | 99 | 99 | 99 |
| EG Level 2: | 72 | 99 | 99 | 76 | 99 | 99 |
| EG Level 3: | 00 | 83 | 77 | 00 | 99 | 77 |
| EG Level 4: | 00 | 00 | 00 | 00 | 00 | 00 |

Keyboard Level Scaling

| | | | | | | |
|---------------------------|------|------|------|------|------|------|
| Break Pt.: | A-1 | A-1 | A-1 | C3 | A-1 | A-1 |
| Curve L: | -LIN | -LIN | -LIN | -LIN | -LIN | -LIN |
| Curve R: | -LIN | -LIN | -LIN | +LIN | -LIN | -LIN |
| Depth L: | 00 | 00 | 00 | 20 | 00 | 00 |
| Depth R: | 00 | 00 | 00 | 08 | 00 | 00 |
| Kbd. Rate Scaling: | 0 | 0 | 0 | 0 | 0 | 0 |
| Op. Outpt. Level: | 85 | 78 | 79 | 81 | 83 | 75 |
| K. Velocity Sens.: | 3 | 3 | 0 | 0 | 0 | 0 |

Pitch EG

| | |
|-------------------|--------------------|
| Rate 1: 99 | Level 1: 50 |
| Rate 2: 99 | Level 2: 50 |
| Rate 3: 99 | Level 3: 50 |
| Rate 4: 99 | Level 4: 50 |

Poly/Mono: Poly

| | | |
|--------------------|---------------|-------------|
| Pitch Bend: | Range | Step |
| | 06 [maximum!] | 00 |

| | | | |
|--------------------|------------------|------------------|--------------------|
| Portamento: | Mode | Glissando | Time |
| | Sus-Key P Retain | Off | 00 – 99 [variable] |

| | Range | Pitch | Amplitude | EG Bias |
|--------------------------|-------|-------|-----------|---------|
| Modulation Wheel: | 00 | Off | Off | Off |
| Foot Control: | 00 | Off | Off | Off |
| Breath Control: | 60 | On | On | On |
| Aftertouch: | 00 | Off | Off | Off |

VOICE DATA for the MIDI WIND INSTRUMENT'S SOUND-SOURCE, as used in the World Première Performance:

Yamaha DX7 (Series I)

VOICE NAME: /S Vox 3

Created by: Ian Shanahan

Algorithm: 28

Feedback: 0

Key Transpose: C3

Pitch Modulation Sensitivity: 1

Oscillator Synchronization: On

| LFO: Wave | Speed | Delay | PMD | AMD | Sync |
|-----------|-------|-------|-----|-----|------|
| Triangle | 08 | 81 | 18 | 99 | On |

| | Operator 1 | Operator 2 | Operator 3 | Operator 4 | Operator 5 | Operator 6 |
|--------------------------|------------|------------|------------|------------|------------|------------|
| Ampl. Mod. Sens.: | 0 | 0 | 0 | 0 | 0 | 3 |
| Mode: | Fixed Hz | Ratio | Ratio | Fixed Hz | Fixed Hz | Ratio |
| Frequency: | 204.2 | 01.00 | 01.00 | 1.585 | 3.715 | 01.00 |
| Detune: | +4 | +1 | +0 | +7 | -3 | -2 |
| EG Rate 1: | 30 | 92 | 30 | 30 | 92 | 30 |
| EG Rate 2: | 21 | 00 | 00 | 24 | 00 | 00 |
| EG Rate 3: | 00 | 00 | 05 | 10 | 00 | 05 |
| EG Rate 4: | 28 | 28 | 28 | 28 | 28 | 28 |
| EG Level 1: | 99 | 99 | 99 | 99 | 99 | 99 |
| EG Level 2: | 72 | 99 | 99 | 76 | 99 | 99 |
| EG Level 3: | 00 | 83 | 77 | 00 | 99 | 77 |
| EG Level 4: | 00 | 00 | 00 | 00 | 00 | 00 |

Keyboard Level Scaling

| | | | | | | |
|---------------------------|------|------|------|------|------|------|
| Break Pt.: | A-1 | A-1 | A-1 | C3 | A-1 | A-1 |
| Curve L: | -LIN | -LIN | -LIN | -LIN | -LIN | -LIN |
| Curve R: | -LIN | -LIN | -LIN | +LIN | -LIN | -LIN |
| Depth L: | 00 | 00 | 00 | 20 | 00 | 00 |
| Depth R: | 00 | 00 | 00 | 08 | 00 | 00 |
| Kbd. Rate Scaling: | 0 | 0 | 0 | 0 | 0 | 0 |
| Op. Outpt. Level: | 85 | 78 | 83 | 81 | 83 | 75 |
| K. Velocity Sens.: | 3 | 3 | 0 | 0 | 0 | 0 |

Pitch EG

| | |
|-------------------|--------------------|
| Rate 1: 99 | Level 1: 50 |
| Rate 2: 99 | Level 2: 50 |
| Rate 3: 99 | Level 3: 50 |
| Rate 4: 99 | Level 4: 50 |

Poly/Mono: Poly

| | | |
|--------------------|---------------|-------------|
| Pitch Bend: | Range | Step |
| | 06 [maximum!] | 00 |

| | | | |
|--------------------|------------------|------------------|--------------------|
| Portamento: | Mode | Glissando | Time |
| | Sus-Key P Retain | Off | 00 – 99 [variable] |

| | Range | Pitch | Amplitude | EG Bias |
|--------------------------|-------|-------|-----------|---------|
| Modulation Wheel: | 00 | Off | Off | Off |
| Foot Control: | 00 | Off | Off | Off |
| Breath Control: | 60 | On | On | On |
| Aftertouch: | 00 | Off | Off | Off |

VOICE DATA for the MIDI WIND INSTRUMENT'S SOUND-SOURCE, as used in the World Première Performance:

Yamaha DX7 (Series I)

VOICE NAME: /S Vox 4

Created by: Ian Shanahan

Algorithm: 28

Feedback: 0

Key Transpose: C3

Pitch Modulation Sensitivity: 1

Oscillator Synchronization: On

| LFO: Wave | Speed | Delay | PMD | AMD | Sync |
|-----------|-------|-------|-----|-----|------|
| Sine | 13 | 37 | 09 | 99 | On |

| | Operator 1 | Operator 2 | Operator 3 | Operator 4 | Operator 5 | Operator 6 |
|--------------------------|------------|------------|------------|------------|------------|------------|
| Ampl. Mod. Sens.: | 0 | 0 | 0 | 0 | 0 | 3 |
| Mode: | Fixed Hz | Ratio | Ratio | Fixed Hz | Fixed Hz | Ratio |
| Frequency: | 371.5 | 01.00 | 01.00 | 5.012 | 1.698 | 01.00 |
| Detune: | +7 | -2 | +0 | +6 | +3 | +1 |
| EG Rate 1: | 30 | 92 | 30 | 30 | 92 | 30 |
| EG Rate 2: | 21 | 00 | 00 | 24 | 00 | 00 |
| EG Rate 3: | 00 | 00 | 05 | 10 | 00 | 05 |
| EG Rate 4: | 28 | 28 | 28 | 28 | 28 | 28 |
| EG Level 1: | 99 | 99 | 99 | 99 | 99 | 99 |
| EG Level 2: | 72 | 99 | 99 | 76 | 99 | 99 |
| EG Level 3: | 00 | 83 | 77 | 00 | 99 | 77 |
| EG Level 4: | 00 | 00 | 00 | 00 | 00 | 00 |

Keyboard Level Scaling

| | | | | | | |
|---------------------------|------|------|------|------|------|------|
| Break Pt.: | A-1 | A-1 | A-1 | C3 | A-1 | A-1 |
| Curve L: | -LIN | -LIN | -LIN | -LIN | -LIN | -LIN |
| Curve R: | -LIN | -LIN | -LIN | +LIN | -LIN | -LIN |
| Depth L: | 00 | 00 | 00 | 20 | 00 | 00 |
| Depth R: | 00 | 00 | 00 | 08 | 00 | 00 |
| Kbd. Rate Scaling: | 0 | 0 | 0 | 0 | 0 | 0 |
| Op. Outpt. Level: | 87 | 78 | 87 | 81 | 83 | 75 |
| K. Velocity Sens.: | 3 | 3 | 0 | 0 | 0 | 0 |

Pitch EG

| | |
|-------------------|--------------------|
| Rate 1: 99 | Level 1: 50 |
| Rate 2: 99 | Level 2: 50 |
| Rate 3: 99 | Level 3: 50 |
| Rate 4: 99 | Level 4: 50 |

Poly/Mono: Poly

| | | |
|--------------------|---------------|-------------|
| Pitch Bend: | Range | Step |
| | 06 [maximum!] | 00 |

| | | | |
|--------------------|------------------|------------------|--------------------|
| Portamento: | Mode | Glissando | Time |
| | Sus-Key P Retain | Off | 00 – 99 [variable] |

| | Range | Pitch | Amplitude | EG Bias |
|--------------------------|-------|-------|-----------|---------|
| Modulation Wheel: | 00 | Off | Off | Off |
| Foot Control: | 00 | Off | Off | Off |
| Breath Control: | 60 | On | On | On |
| Aftertouch: | 00 | Off | Off | Off |

VOICE DATA for the MIDI WIND INSTRUMENT'S SOUND-SOURCE, as used in the World Première Performance:

Yamaha DX7 (Series I)

VOICE NAME: /S Vox 5

Created by: Ian Shanahan

Algorithm: 28

Feedback: 0

Key Transpose: C3

Pitch Modulation Sensitivity: 1

Oscillator Synchronization: On

| LFO: Wave | Speed | Delay | PMD | AMD | Sync |
|-----------|-------|-------|-----|-----|------|
| Sine | 07 | 28 | 11 | 99 | On |

| | Operator 1 | Operator 2 | Operator 3 | Operator 4 | Operator 5 | Operator 6 |
|--------------------------|------------|------------|------------|------------|------------|------------|
| Ampl. Mod. Sens.: | 0 | 0 | 0 | 0 | 0 | 3 |
| Mode: | Fixed Hz | Ratio | Ratio | Fixed Hz | Fixed Hz | Ratio |
| Frequency: | 575.4 | 01.00 | 01.00 | 8.128 | 1.905 | 01.00 |
| Detune: | -4 | -2 | +0 | -7 | +7 | +0 |
| EG Rate 1: | 30 | 92 | 30 | 30 | 92 | 30 |
| EG Rate 2: | 21 | 00 | 00 | 24 | 00 | 00 |
| EG Rate 3: | 00 | 00 | 05 | 10 | 00 | 05 |
| EG Rate 4: | 28 | 28 | 28 | 28 | 28 | 28 |
| EG Level 1: | 99 | 99 | 99 | 99 | 99 | 99 |
| EG Level 2: | 72 | 99 | 99 | 76 | 99 | 99 |
| EG Level 3: | 00 | 83 | 77 | 00 | 99 | 77 |
| EG Level 4: | 00 | 00 | 00 | 00 | 00 | 00 |

Keyboard Level Scaling

| | | | | | | |
|---------------------------|------|------|------|------|------|------|
| Break Pt.: | A-1 | A-1 | A-1 | C3 | A-1 | A-1 |
| Curve L: | -LIN | -LIN | -LIN | -LIN | -LIN | -LIN |
| Curve R: | -LIN | -LIN | -LIN | +LIN | -LIN | -LIN |
| Depth L: | 00 | 00 | 00 | 20 | 00 | 00 |
| Depth R: | 00 | 00 | 00 | 08 | 00 | 00 |
| Kbd. Rate Scaling: | 0 | 0 | 0 | 0 | 0 | 0 |
| Op. Outpt. Level: | 87 | 78 | 85 | 81 | 83 | 75 |
| K. Velocity Sens.: | 3 | 3 | 0 | 0 | 0 | 0 |

Pitch EG

| | |
|-------------------|--------------------|
| Rate 1: 99 | Level 1: 50 |
| Rate 2: 99 | Level 2: 50 |
| Rate 3: 99 | Level 3: 50 |
| Rate 4: 99 | Level 4: 50 |

Poly/Mono: Poly

| | | |
|--------------------|---------------|-------------|
| Pitch Bend: | Range | Step |
| | 06 [maximum!] | 00 |

| | | | |
|--------------------|------------------|------------------|--------------------|
| Portamento: | Mode | Glissando | Time |
| | Sus-Key P Retain | Off | 00 – 99 [variable] |

| | Range | Pitch | Amplitude | EG Bias |
|--------------------------|-------|-------|-----------|---------|
| Modulation Wheel: | 00 | Off | Off | Off |
| Foot Control: | 00 | Off | Off | Off |
| Breath Control: | 60 | On | On | On |
| Aftertouch: | 00 | Off | Off | Off |

VOICE DATA for the MIDI WIND INSTRUMENT'S SOUND-SOURCE, as used in the World Première Performance:

Yamaha DX7 (Series I)

VOICE NAME: /S Vox 6

Created by: Ian Shanahan

Algorithm: 28

Feedback: 0

Key Transpose: C3

Pitch Modulation Sensitivity: 1

Oscillator Synchronization: On

| LFO: Wave | Speed | Delay | PMD | AMD | Sync |
|-----------|-------|-------|-----|-----|------|
| Sine | 06 | 77 | 12 | 99 | On |

| | Operator 1 | Operator 2 | Operator 3 | Operator 4 | Operator 5 | Operator 6 |
|--------------------------|------------|------------|------------|------------|------------|------------|
| Ampl. Mod. Sens.: | 0 | 0 | 0 | 0 | 0 | 3 |
| Mode: | Fixed Hz | Ratio | Ratio | Fixed Hz | Fixed Hz | Ratio |
| Frequency: | 707.9 | 01.00 | 01.00 | 2.291 | 1.349 | 01.00 |
| Detune: | -1 | -1 | +0 | +0 | +1 | -3 |
| EG Rate 1: | 30 | 92 | 30 | 30 | 92 | 30 |
| EG Rate 2: | 21 | 00 | 00 | 24 | 00 | 00 |
| EG Rate 3: | 00 | 00 | 05 | 10 | 00 | 05 |
| EG Rate 4: | 28 | 28 | 28 | 28 | 28 | 28 |
| EG Level 1: | 99 | 99 | 99 | 99 | 99 | 99 |
| EG Level 2: | 72 | 99 | 99 | 76 | 99 | 99 |
| EG Level 3: | 00 | 83 | 77 | 00 | 99 | 77 |
| EG Level 4: | 00 | 00 | 00 | 00 | 00 | 00 |

Keyboard Level Scaling

| | | | | | | |
|---------------------------|------|------|------|------|------|------|
| Break Pt.: | A-1 | A-1 | A-1 | C3 | A-1 | A-1 |
| Curve L: | -LIN | -LIN | -LIN | -LIN | -LIN | -LIN |
| Curve R: | -LIN | -LIN | -LIN | +LIN | -LIN | -LIN |
| Depth L: | 00 | 00 | 00 | 20 | 00 | 00 |
| Depth R: | 00 | 00 | 00 | 08 | 00 | 00 |
| Kbd. Rate Scaling: | 0 | 0 | 0 | 0 | 0 | 0 |
| Op. Outpt. Level: | 87 | 78 | 80 | 81 | 83 | 75 |
| K. Velocity Sens.: | 3 | 3 | 0 | 0 | 0 | 0 |

Pitch EG

| | |
|-------------------|--------------------|
| Rate 1: 99 | Level 1: 50 |
| Rate 2: 99 | Level 2: 50 |
| Rate 3: 99 | Level 3: 50 |
| Rate 4: 99 | Level 4: 50 |

Poly/Mono: Poly

| | | |
|--------------------|---------------|-------------|
| Pitch Bend: | Range | Step |
| | 06 [maximum!] | 00 |

| | | | |
|--------------------|------------------|------------------|--------------------|
| Portamento: | Mode | Glissando | Time |
| | Sus-Key P Retain | Off | 00 – 99 [variable] |

| | Range | Pitch | Amplitude | EG Bias |
|--------------------------|-------|-------|-----------|---------|
| Modulation Wheel: | 00 | Off | Off | Off |
| Foot Control: | 00 | Off | Off | Off |
| Breath Control: | 60 | On | On | On |
| Aftertouch: | 00 | Off | Off | Off |

VOICE DATA for the MIDI WIND INSTRUMENT'S SOUND-SOURCE, as used in the World Première Performance:

Yamaha DX7 (Series I)

VOICE NAME: /S Vox 7

Created by: Ian Shanahan

Algorithm: 28

Feedback: 0

Key Transpose: C3

Pitch Modulation Sensitivity: 1

Oscillator Synchronization: On

| LFO: Wave | Speed | Delay | PMD | AMD | Sync |
|-----------|-------|-------|-----|-----|------|
| Triangle | 06 | 28 | 14 | 99 | On |

| | Operator 1 | Operator 2 | Operator 3 | Operator 4 | Operator 5 | Operator 6 |
|--------------------------|------------|------------|------------|------------|------------|------------|
| Ampl. Mod. Sens.: | 0 | 0 | 0 | 0 | 0 | 3 |
| Mode: | Fixed Hz | Ratio | Ratio | Fixed Hz | Fixed Hz | Ratio |
| Frequency: | 1096. | 01.00 | 01.00 | 3.236 | 1.995 | 01.00 |
| Detune: | +7 | +0 | +0 | -1 | +3 | -2 |
| EG Rate 1: | 30 | 92 | 30 | 30 | 92 | 30 |
| EG Rate 2: | 21 | 00 | 00 | 24 | 00 | 00 |
| EG Rate 3: | 00 | 00 | 05 | 10 | 00 | 05 |
| EG Rate 4: | 28 | 28 | 28 | 28 | 28 | 28 |
| EG Level 1: | 99 | 99 | 99 | 99 | 99 | 99 |
| EG Level 2: | 72 | 99 | 99 | 76 | 99 | 99 |
| EG Level 3: | 00 | 83 | 77 | 00 | 99 | 77 |
| EG Level 4: | 00 | 00 | 00 | 00 | 00 | 00 |

Keyboard Level Scaling

| | | | | | | |
|---------------------------|------|------|------|------|------|------|
| Break Pt.: | A-1 | A-1 | A-1 | C3 | A-1 | A-1 |
| Curve L: | -LIN | -LIN | -LIN | -LIN | -LIN | -LIN |
| Curve R: | -LIN | -LIN | -LIN | +LIN | -LIN | -LIN |
| Depth L: | 00 | 00 | 00 | 20 | 00 | 00 |
| Depth R: | 00 | 00 | 00 | 08 | 00 | 00 |
| Kbd. Rate Scaling: | 0 | 0 | 0 | 0 | 0 | 0 |
| Op. Outpt. Level: | 87 | 78 | 83 | 81 | 83 | 75 |
| K. Velocity Sens.: | 3 | 3 | 0 | 0 | 0 | 0 |

Pitch EG

| | |
|-------------------|--------------------|
| Rate 1: 99 | Level 1: 50 |
| Rate 2: 99 | Level 2: 50 |
| Rate 3: 99 | Level 3: 50 |
| Rate 4: 99 | Level 4: 50 |

Poly/Mono: Poly

| | | |
|--------------------|---------------|-------------|
| Pitch Bend: | Range | Step |
| | 06 [maximum!] | 00 |

| | | | |
|--------------------|------------------|------------------|--------------------|
| Portamento: | Mode | Glissando | Time |
| | Sus-Key P Retain | Off | 00 – 99 [variable] |

| | Range | Pitch | Amplitude | EG Bias |
|--------------------------|-------|-------|-----------|---------|
| Modulation Wheel: | 00 | Off | Off | Off |
| Foot Control: | 00 | Off | Off | Off |
| Breath Control: | 60 | On | On | On |
| Aftertouch: | 00 | Off | Off | Off |

VOICE DATA for the MIDI WIND INSTRUMENT'S SOUND-SOURCE, as used in the World Première Performance:

Yamaha DX7 (Series I)

VOICE NAME: /S Vox 8

Created by: Ian Shanahan

Algorithm: 28

Feedback: 0

Key Transpose: C3

Pitch Modulation Sensitivity: 1

Oscillator Synchronization: On

| LFO: Wave | Speed | Delay | PMD | AMD | Sync |
|-----------|-------|-------|-----|-----|------|
| Sine | 09 | 00 | 11 | 40 | On |

| | Operator 1 | Operator 2 | Operator 3 | Operator 4 | Operator 5 | Operator 6 |
|--------------------------|------------|------------|------------|------------|------------|------------|
| Ampl. Mod. Sens.: | 0 | 0 | 0 | 0 | 0 | 3 |
| Mode: | Fixed Hz | Ratio | Ratio | Fixed Hz | Fixed Hz | Ratio |
| Frequency: | 1549. | 01.00 | 01.00 | 2.716 | 1.862 | 01.00 |
| Detune: | -2 | +5 | +0 | -7 | +4 | -2 |
| EG Rate 1: | 30 | 92 | 30 | 30 | 92 | 30 |
| EG Rate 2: | 21 | 00 | 00 | 24 | 00 | 00 |
| EG Rate 3: | 00 | 00 | 05 | 10 | 00 | 05 |
| EG Rate 4: | 28 | 28 | 28 | 28 | 28 | 28 |
| EG Level 1: | 99 | 99 | 99 | 99 | 99 | 99 |
| EG Level 2: | 72 | 99 | 99 | 76 | 99 | 99 |
| EG Level 3: | 00 | 83 | 77 | 00 | 99 | 77 |
| EG Level 4: | 00 | 00 | 00 | 00 | 00 | 00 |

Keyboard Level Scaling

| | | | | | | |
|---------------------------|------|------|------|------|------|------|
| Break Pt.: | A-1 | A-1 | A-1 | C3 | A-1 | A-1 |
| Curve L: | -LIN | -LIN | -LIN | -LIN | -LIN | -LIN |
| Curve R: | -LIN | -LIN | -LIN | +LIN | -LIN | -LIN |
| Depth L: | 00 | 00 | 00 | 20 | 00 | 00 |
| Depth R: | 00 | 00 | 00 | 08 | 00 | 00 |
| Kbd. Rate Scaling: | 0 | 0 | 0 | 0 | 0 | 0 |
| Op. Outpt. Level: | 87 | 78 | 77 | 81 | 83 | 75 |
| K. Velocity Sens.: | 3 | 3 | 0 | 0 | 0 | 0 |

Pitch EG

| | |
|-------------------|--------------------|
| Rate 1: 99 | Level 1: 50 |
| Rate 2: 99 | Level 2: 50 |
| Rate 3: 99 | Level 3: 50 |
| Rate 4: 99 | Level 4: 50 |

Poly/Mono: Poly

| | | |
|--------------------|---------------|-------------|
| Pitch Bend: | Range | Step |
| | 06 [maximum!] | 00 |

| | | | |
|--------------------|------------------|------------------|--------------------|
| Portamento: | Mode | Glissando | Time |
| | Sus-Key P Retain | Off | 00 – 99 [variable] |

| | Range | Pitch | Amplitude | EG Bias |
|--------------------------|-------|-------|-----------|---------|
| Modulation Wheel: | 00 | Off | Off | Off |
| Foot Control: | 00 | Off | Off | Off |
| Breath Control: | 60 | On | On | On |
| Aftertouch: | 00 | Off | Off | Off |

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VOICE DATA for the MIDI WIND INSTRUMENT'S SOUND-SOURCE, as used in the World Première Performance:

Yamaha DX7 (Series I)

VOICE NAME: /S Vox 9

Created by: Ian Shanahan

Algorithm: 28

Feedback: 0

Key Transpose: C3

Pitch Modulation Sensitivity: 1

Oscillator Synchronization: On

| LFO: Wave | Speed | Delay | PMD | AMD | Sync |
|-----------|-------|-------|-----|-----|------|
| Triangle | 02 | 67 | 10 | 99 | On |

| | Operator 1 | Operator 2 | Operator 3 | Operator 4 | Operator 5 | Operator 6 |
|--------------------------|------------|------------|------------|------------|------------|------------|
| Ampl. Mod. Sens.: | 0 | 0 | 0 | 0 | 0 | 3 |
| Mode: | Fixed Hz | Ratio | Ratio | Fixed Hz | Fixed Hz | Ratio |
| Frequency: | 2089. | 01.00 | 01.00 | 5.623 | 1.259 | 01.00 |
| Detune: | -7 | -1 | +0 | -6 | +4 | +2 |
| EG Rate 1: | 30 | 92 | 30 | 30 | 92 | 30 |
| EG Rate 2: | 21 | 00 | 00 | 24 | 00 | 00 |
| EG Rate 3: | 00 | 00 | 05 | 10 | 00 | 05 |
| EG Rate 4: | 28 | 28 | 28 | 28 | 28 | 28 |
| EG Level 1: | 99 | 99 | 99 | 99 | 99 | 99 |
| EG Level 2: | 72 | 99 | 99 | 76 | 99 | 99 |
| EG Level 3: | 00 | 83 | 77 | 00 | 99 | 77 |
| EG Level 4: | 00 | 00 | 00 | 00 | 00 | 00 |

Keyboard Level Scaling

| | | | | | | |
|---------------------------|------|------|------|------|------|------|
| Break Pt.: | A-1 | A-1 | A-1 | C3 | A-1 | A-1 |
| Curve L: | -LIN | -LIN | -LIN | -LIN | -LIN | -LIN |
| Curve R: | -LIN | -LIN | -LIN | +LIN | -LIN | -LIN |
| Depth L: | 00 | 00 | 00 | 20 | 00 | 00 |
| Depth R: | 00 | 00 | 00 | 08 | 00 | 00 |
| Kbd. Rate Scaling: | 0 | 0 | 0 | 0 | 0 | 0 |
| Op. Outpt. Level: | 87 | 78 | 87 | 81 | 83 | 75 |
| K. Velocity Sens.: | 3 | 3 | 0 | 0 | 0 | 0 |

Pitch EG

| | |
|-------------------|--------------------|
| Rate 1: 99 | Level 1: 50 |
| Rate 2: 99 | Level 2: 50 |
| Rate 3: 99 | Level 3: 50 |
| Rate 4: 99 | Level 4: 50 |

Poly/Mono: Poly

| | | |
|--------------------|---------------|-------------|
| Pitch Bend: | Range | Step |
| | 06 [maximum!] | 00 |

| | | | |
|--------------------|------------------|------------------|--------------------|
| Portamento: | Mode | Glissando | Time |
| | Sus-Key P Retain | Off | 00 – 99 [variable] |

| | Range | Pitch | Amplitude | EG Bias |
|--------------------------|-------|-------|-----------|---------|
| Modulation Wheel: | 00 | Off | Off | Off |
| Foot Control: | 00 | Off | Off | Off |
| Breath Control: | 60 | On | On | On |
| Aftertouch: | 00 | Off | Off | Off |

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**VOICE DATA for the KEYBOARD SYNTHESIZER, as used in the
World Première Performance:**

Yamaha DX7

VOICE NAME: *Bowed Crot*

Created by: Ian Shanahan

Algorithm: 05

Feedback: 1

Key Transpose: C2

Pitch Modulation Sensitivity: 1

Oscillator Synchronization: On

| LFO: Wave | Speed | Delay | PMD | AMD | Sync |
|-----------|-------|-------|-----|-----|------|
| Triangle | 20 | 91 | 08 | 00 | On |

| | Operator 1 | Operator 2 | Operator 3 | Operator 4 | Operator 5 | Operator 6 |
|--------------------------|------------|------------|------------|------------|------------|------------|
| Ampl. Mod. Sens.: | 0 | 0 | 0 | 0 | 0 | 0 |
| Mode: | Ratio | Ratio | Ratio | Ratio | Ratio | Ratio |
| Frequency: | 02.00 | 13.00 | 02.00 | 13.00 | 02.00 | 13.00 |
| Detune: | +3 | -3 | +0 | +1 | -7 | +7 |
| EG Rate 1: | 39 | 76 | 39 | 75 | 39 | 74 |
| EG Rate 2: | 31 | 20 | 32 | 22 | 39 | 28 |
| EG Rate 3: | 13 | 14 | 15 | 15 | 47 | 30 |
| EG Rate 4: | 33 | 19 | 32 | 18 | 37 | 39 |
| EG Level 1: | 99 | 99 | 99 | 99 | 99 | 99 |
| EG Level 2: | 73 | 63 | 75 | 67 | 72 | 66 |
| EG Level 3: | 00 | 00 | 00 | 00 | 00 | 00 |
| EG Level 4: | 00 | 00 | 00 | 00 | 00 | 00 |

Keyboard Level Scaling

| | | | | | | |
|---------------------------|------|------|------|------|------|------|
| Break Pt.: | A-1 | A-1 | A-1 | A-1 | A-1 | A-1 |
| Curve L: | -LIN | -LIN | -LIN | -LIN | -LIN | -LIN |
| Curve R: | -LIN | -LIN | -LIN | -LIN | -LIN | -LIN |
| Depth L: | 00 | 00 | 00 | 00 | 00 | 00 |
| Depth R: | 00 | 00 | 00 | 00 | 00 | 00 |
| Kbd. Rate Scaling: | 0 | 2 | 0 | 2 | 1 | 3 |
| Op. Outpt. Level: | 99 | 99 | 99 | 99 | 99 | 99 |
| K. Velocity Sens.: | 4 | 2 | 4 | 2 | 7 | 5 |

Pitch EG

| | |
|-------------------|--------------------|
| Rate 1: 99 | Level 1: 50 |
| Rate 2: 99 | Level 2: 50 |
| Rate 3: 99 | Level 3: 50 |
| Rate 4: 99 | Level 4: 50 |

Poly/Mono: Poly

| Pitch Bend: | Range | Step |
|-------------|-------|------|
| | 01 | 00 |

| Portamento: | Mode | Glissando | Time |
|-------------|------------------|-----------|---------------------------------------|
| | Sus-Key P Retain | Off | 00, or 00 – 99 [optional variability] |

| | Range | Pitch | Amplitude | EG Bias |
|--------------------------|-------|-------|-----------|---------|
| Modulation Wheel: | 00 | Off | Off | Off |
| Foot Control: | 00 | Off | Off | Off |
| Breath Control: | 00 | Off | Off | Off |
| Aftertouch: | 00 | Off | Off | Off |

**VOICE DATA for the KEYBOARD SYNTHESIZER, as used in the
World Première Performance:**

Yamaha DX7

VOICE NAME: *VibeSizzle*

Created by: Ian Shanahan

Algorithm: 29

Feedback: 3

Key Transpose: A1

Pitch Modulation Sensitivity: 1

Oscillator Synchronization: On

| LFO: Wave | Speed | Delay | PMD | AMD | Sync |
|-----------|-------|-------|-----|-----|------|
| Sine | 14 | 99 | 13 | 12 | On |

| | Operator 1 | Operator 2 | Operator 3 | Operator 4 | Operator 5 | Operator 6 |
|--------------------------|------------|------------|------------|------------|------------|------------|
| Ampl. Mod. Sens.: | 0 | 0 | 0 | 1 | 0 | 0 |
| Mode: | Ratio | Ratio | Ratio | Ratio | Ratio | Ratio |
| Frequency: | 04.71 | 04.71 | 02.00 | 13.00 | 02.00 | 13.00 |
| Detune: | +3 | -2 | -3 | +0 | +3 | -4 |
| EG Rate 1: | 58 | 61 | 18 | 79 | 39 | 83 |
| EG Rate 2: | 00 | 38 | 22 | 16 | 22 | 13 |
| EG Rate 3: | 21 | 19 | 27 | 15 | 28 | 14 |
| EG Rate 4: | 27 | 28 | 29 | 21 | 29 | 20 |
| EG Level 1: | 99 | 99 | 94 | 99 | 99 | 99 |
| EG Level 2: | 99 | 86 | 67 | 81 | 67 | 82 |
| EG Level 3: | 00 | 00 | 00 | 00 | 00 | 00 |
| EG Level 4: | 00 | 00 | 00 | 00 | 00 | 00 |

Keyboard Level Scaling

| | | | | | | |
|---------------------------|------|------|------|------|------|------|
| Break Pt.: | A-1 | A-1 | A-1 | A-1 | A-1 | A-1 |
| Curve L: | -LIN | -LIN | -LIN | -LIN | -LIN | -LIN |
| Curve R: | -LIN | -LIN | -LIN | -LIN | -LIN | -LIN |
| Depth L: | 00 | 00 | 00 | 00 | 00 | 00 |
| Depth R: | 00 | 00 | 00 | 00 | 00 | 00 |
| Kbd. Rate Scaling: | 2 | 0 | 0 | 4 | 0 | 4 |
| Op. Outpt. Level: | 99 | 99 | 80 | 99 | 79 | 99 |
| K. Velocity Sens.: | 4 | 4 | 4 | 1 | 4 | 1 |

Pitch EG

| | |
|-------------------|--------------------|
| Rate 1: 99 | Level 1: 50 |
| Rate 2: 99 | Level 2: 50 |
| Rate 3: 99 | Level 3: 50 |
| Rate 4: 99 | Level 4: 50 |

Poly/Mono: Poly

| Pitch Bend: | Range | Step |
|-------------|-------|------|
| | 01 | 00 |

| Portamento: | Mode | Glissando | Time |
|-------------|------------------|-----------|---------------------------------------|
| | Sus-Key P Retain | Off | 00, or 00 – 99 [optional variability] |

| | Range | Pitch | Amplitude | EG Bias |
|--------------------------|-------|-------|-----------|---------|
| Modulation Wheel: | 00 | Off | Off | Off |
| Foot Control: | 00 | Off | Off | Off |
| Breath Control: | 00 | Off | Off | Off |
| Aftertouch: | 00 | Off | Off | Off |

**VOICE DATA for the KEYBOARD SYNTHESIZER, as used in the
World Première Performance:**

Yamaha DX7

VOICE NAME: *LowHollow1*

Created by: Ian Shanahan

Algorithm: 05

Feedback: 0

Key Transpose: E2

Pitch Modulation Sensitivity: 1

Oscillator Synchronization: On

| LFO: Wave | Speed | Delay | PMD | AMD | Sync |
|-----------|-------|-------|-----|-----|------|
| Triangle | 06 | 73 | 19 | 00 | On |

| | Operator 1 | Operator 2 | Operator 3 | Operator 4 | Operator 5 | Operator 6 |
|--------------------------|------------|------------|------------|------------|------------|------------|
| Ampl. Mod. Sens.: | 0 | 0 | 0 | 0 | 0 | 0 |
| Mode: | Ratio | Ratio | Ratio | Ratio | Ratio | Ratio |
| Frequency: | 00.78 | 05.00 | 00.78 | 05.00 | 00.78 | 05.00 |
| Detune: | +3 | -1 | -4 | +5 | -2 | +2 |
| EG Rate 1: | 76 | 79 | 75 | 78 | 72 | 80 |
| EG Rate 2: | 28 | 31 | 25 | 29 | 23 | 32 |
| EG Rate 3: | 29 | 15 | 31 | 14 | 28 | 13 |
| EG Rate 4: | 34 | 17 | 36 | 18 | 35 | 16 |
| EG Level 1: | 99 | 99 | 99 | 99 | 99 | 99 |
| EG Level 2: | 83 | 85 | 82 | 83 | 81 | 86 |
| EG Level 3: | 00 | 00 | 00 | 00 | 00 | 00 |
| EG Level 4: | 00 | 00 | 00 | 00 | 00 | 00 |

Keyboard Level Scaling

| | | | | | | |
|---------------------------|------|------|------|------|------|------|
| Break Pt.: | A-1 | A-1 | A-1 | A-1 | A-1 | A-1 |
| Curve L: | -LIN | -LIN | -LIN | -LIN | -LIN | -LIN |
| Curve R: | -LIN | -LIN | -LIN | -LIN | -LIN | -LIN |
| Depth L: | 00 | 00 | 00 | 00 | 00 | 00 |
| Depth R: | 00 | 00 | 00 | 00 | 00 | 00 |
| Kbd. Rate Scaling: | 0 | 0 | 0 | 0 | 0 | 0 |
| Op. Outpt. Level: | 99 | 86 | 99 | 85 | 99 | 84 |
| K. Velocity Sens.: | 4 | 4 | 4 | 4 | 4 | 4 |

Pitch EG

| | |
|-------------------|--------------------|
| Rate 1: 99 | Level 1: 50 |
| Rate 2: 99 | Level 2: 50 |
| Rate 3: 99 | Level 3: 50 |
| Rate 4: 99 | Level 4: 50 |

Poly/Mono: Poly

| Pitch Bend: | Range | Step |
|-------------|-------|------|
| | 01 | 00 |

| Portamento: | Mode | Glissando | Time |
|-------------|------------------|-----------|---------------------------------------|
| | Sus-Key P Retain | Off | 00, or 00 – 99 [optional variability] |

| | Range | Pitch | Amplitude | EG Bias |
|--------------------------|-------|-------|-----------|---------|
| Modulation Wheel: | 00 | Off | Off | Off |
| Foot Control: | 00 | Off | Off | Off |
| Breath Control: | 00 | Off | Off | Off |
| Aftertouch: | 00 | Off | Off | Off |

**VOICE DATA for the KEYBOARD SYNTHESIZER, as used in the
World Première Performance:**

Yamaha DX7

VOICE NAME: *LowHollow2*

Created by: Ian Shanahan

Algorithm: 05

Feedback: 2

Key Transpose: D2

Pitch Modulation Sensitivity: 1

Oscillator Synchronization: On

| LFO: Wave | Speed | Delay | PMD | AMD | Sync |
|-----------|-------|-------|-----|-----|------|
| Triangle | 15 | 88 | 10 | 00 | On |

| | Operator 1 | Operator 2 | Operator 3 | Operator 4 | Operator 5 | Operator 6 |
|--------------------------|------------|------------|------------|------------|------------|------------|
| Ampl. Mod. Sens.: | 0 | 0 | 0 | 0 | 0 | 0 |
| Mode: | Ratio | Ratio | Ratio | Ratio | Ratio | Ratio |
| Frequency: | 00.86 | 05.00 | 00.86 | 05.00 | 00.86 | 05.00 |
| Detune: | +1 | +7 | -2 | +2 | +2 | -1 |
| EG Rate 1: | 58 | 76 | 59 | 79 | 57 | 74 |
| EG Rate 2: | 39 | 15 | 33 | 13 | 38 | 00 |
| EG Rate 3: | 20 | 20 | 15 | 21 | 19 | 19 |
| EG Rate 4: | 30 | 22 | 26 | 27 | 34 | 17 |
| EG Level 1: | 99 | 99 | 99 | 99 | 99 | 99 |
| EG Level 2: | 88 | 95 | 94 | 92 | 86 | 99 |
| EG Level 3: | 00 | 00 | 00 | 00 | 00 | 00 |
| EG Level 4: | 00 | 00 | 00 | 00 | 00 | 00 |

Keyboard Level Scaling

| | | | | | | |
|---------------------------|------|------|------|------|------|------|
| Break Pt.: | A-1 | A-1 | A-1 | A-1 | A-1 | A-1 |
| Curve L: | -LIN | -LIN | -LIN | -LIN | -LIN | -LIN |
| Curve R: | -LIN | -LIN | -LIN | -LIN | -LIN | -LIN |
| Depth L: | 00 | 00 | 00 | 00 | 00 | 00 |
| Depth R: | 00 | 00 | 00 | 00 | 00 | 00 |
| Kbd. Rate Scaling: | 0 | 2 | 0 | 2 | 0 | 2 |
| Op. Outpt. Level: | 98 | 83 | 97 | 85 | 99 | 84 |
| K. Velocity Sens.: | 4 | 3 | 4 | 3 | 4 | 3 |

Pitch EG

| | |
|-------------------|--------------------|
| Rate 1: 99 | Level 1: 50 |
| Rate 2: 99 | Level 2: 50 |
| Rate 3: 99 | Level 3: 50 |
| Rate 4: 99 | Level 4: 50 |

Poly/Mono: Poly

| Pitch Bend: | Range | Step |
|-------------|-------|------|
| | 01 | 00 |

| Portamento: | Mode | Glissando | Time |
|-------------|------------------|-----------|---------------------------------------|
| | Sus-Key P Retain | Off | 00, or 00 – 99 [optional variability] |

| | Range | Pitch | Amplitude | EG Bias |
|--------------------------|-------|-------|-----------|---------|
| Modulation Wheel: | 00 | Off | Off | Off |
| Foot Control: | 00 | Off | Off | Off |
| Breath Control: | 00 | Off | Off | Off |
| Aftertouch: | 00 | Off | Off | Off |

**VOICE DATA for the KEYBOARD SYNTHESIZER, as used in the
World Première Performance:**

Yamaha DX7

VOICE NAME: *Chimes 1*

Created by: Ian Shanahan

Algorithm: 29

Feedback: 2

Key Transpose: G # 1

Pitch Modulation Sensitivity: 1

Oscillator Synchronization: On

| LFO: Wave | Speed | Delay | PMD | AMD | Sync |
|-----------|-------|-------|-----|-----|------|
| Triangle | 11 | 82 | 10 | 99 | Off |

| | Operator 1 | Operator 2 | Operator 3 | Operator 4 | Operator 5 | Operator 6 |
|-------------------|------------|------------|------------|------------|------------|------------|
| Ampl. Mod. Sens.: | 0 | 3 | 0 | 0 | 0 | 0 |
| Mode: | Ratio | Ratio | Ratio | Ratio | Ratio | Ratio |
| Frequency: | 05.00 | 05.00 | 14.00 | 05.64 | 14.00 | 05.64 |
| Detune: | -5 | -1 | -3 | +4 | -5 | +2 |
| EG Rate 1: | 58 | 54 | 86 | 78 | 86 | 78 |
| EG Rate 2: | 00 | 07 | 37 | 26 | 27 | 26 |
| EG Rate 3: | 21 | 19 | 41 | 35 | 26 | 35 |
| EG Rate 4: | 27 | 28 | 43 | 19 | 40 | 19 |
| EG Level 1: | 99 | 99 | 99 | 99 | 99 | 99 |
| EG Level 2: | 99 | 92 | 64 | 67 | 64 | 67 |
| EG Level 3: | 00 | 00 | 00 | 00 | 00 | 00 |
| EG Level 4: | 00 | 00 | 00 | 00 | 00 | 00 |

Keyboard Level Scaling

| | | | | | | |
|--------------------|------|------|------|------|------|------|
| Break Pt.: | A-1 | A-1 | A-1 | A-1 | A-1 | A-1 |
| Curve L: | -LIN | -LIN | -LIN | -LIN | -LIN | -LIN |
| Curve R: | -LIN | -LIN | -LIN | -LIN | -LIN | -LIN |
| Depth L: | 00 | 00 | 00 | 00 | 00 | 00 |
| Depth R: | 00 | 00 | 00 | 00 | 00 | 00 |
| Kbd. Rate Scaling: | 2 | 2 | 2 | 4 | 2 | 4 |
| Op. Outpt. Level: | 99 | 99 | 99 | 81 | 99 | 81 |
| K. Velocity Sens.: | 4 | 4 | 4 | 4 | 4 | 4 |

Pitch EG

| | |
|------------|-------------|
| Rate 1: 99 | Level 1: 50 |
| Rate 2: 99 | Level 2: 50 |
| Rate 3: 99 | Level 3: 50 |
| Rate 4: 99 | Level 4: 50 |

Poly/Mono: Poly

| Pitch Bend: | Range | Step |
|-------------|-------|------|
| | 01 | 00 |

| Portamento: | Mode | Glissando | Time |
|-------------|------------------|-----------|---------------------------------------|
| | Sus-Key P Retain | Off | 00, or 00 – 99 [optional variability] |

| | Range | Pitch | Amplitude | EG Bias |
|-------------------|-------|-------|-----------|---------|
| Modulation Wheel: | 00 | Off | Off | Off |
| Foot Control: | 00 | Off | Off | Off |
| Breath Control: | 00 | Off | Off | Off |
| Aftertouch: | 00 | Off | Off | Off |

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**VOICE DATA for the KEYBOARD SYNTHESIZER, as used in the
World Première Performance:**

Yamaha DX7

VOICE NAME: *Chimes 2*

Created by: Ian Shanahan

Algorithm: 05

Feedback: 2

Key Transpose: A # 2

Pitch Modulation Sensitivity: 1

Oscillator Synchronization: On

| LFO: Wave | Speed | Delay | PMD | AMD | Sync |
|-----------|-------|-------|-----|-----|------|
| Triangle | 09 | 99 | 20 | 00 | On |

| | Operator 1 | Operator 2 | Operator 3 | Operator 4 | Operator 5 | Operator 6 |
|-------------------|------------|------------|------------|------------|------------|------------|
| Ampl. Mod. Sens.: | 0 | 0 | 0 | 0 | 0 | 0 |
| Mode: | Ratio | Ratio | Ratio | Ratio | Ratio | Ratio |
| Frequency: | 04.00 | 01.73 | 04.00 | 01.73 | 04.00 | 01.73 |
| Detune: | +0 | +1 | -1 | -1 | +2 | -3 |
| EG Rate 1: | 89 | 90 | 74 | 83 | 86 | 77 |
| EG Rate 2: | 20 | 34 | 08 | 36 | 00 | 38 |
| EG Rate 3: | 24 | 29 | 18 | 31 | 21 | 19 |
| EG Rate 4: | 32 | 28 | 25 | 22 | 30 | 33 |
| EG Level 1: | 99 | 99 | 99 | 99 | 99 | 99 |
| EG Level 2: | 92 | 73 | 92 | 73 | 99 | 66 |
| EG Level 3: | 00 | 00 | 00 | 00 | 00 | 00 |
| EG Level 4: | 00 | 00 | 00 | 00 | 00 | 00 |

Keyboard Level Scaling

| | | | | | | |
|--------------------|------|------|------|------|------|------|
| Break Pt.: | A-1 | A-1 | A-1 | A-1 | A-1 | A-1 |
| Curve L: | -LIN | -LIN | -LIN | -LIN | -LIN | -LIN |
| Curve R: | -LIN | -LIN | -LIN | -LIN | -LIN | -LIN |
| Depth L: | 00 | 00 | 00 | 00 | 00 | 00 |
| Depth R: | 00 | 00 | 00 | 00 | 00 | 00 |
| Kbd. Rate Scaling: | 2 | 0 | 2 | 0 | 2 | 0 |
| Op. Outpt. Level: | 99 | 84 | 99 | 86 | 99 | 85 |
| K. Velocity Sens.: | 5 | 4 | 4 | 4 | 4 | 4 |

Pitch EG

| | |
|------------|-------------|
| Rate 1: 99 | Level 1: 50 |
| Rate 2: 99 | Level 2: 50 |
| Rate 3: 99 | Level 3: 50 |
| Rate 4: 99 | Level 4: 50 |

Poly/Mono: Poly

| Pitch Bend: | Range | Step |
|-------------|-------|------|
| | 01 | 00 |

| Portamento: | Mode | Glissando | Time |
|-------------|------------------|-----------|---------------------------------------|
| | Sus-Key P Retain | Off | 00, or 00 – 99 [optional variability] |

| | Range | Pitch | Amplitude | EG Bias |
|-------------------|-------|-------|-----------|---------|
| Modulation Wheel: | 00 | Off | Off | Off |
| Foot Control: | 00 | Off | Off | Off |
| Breath Control: | 00 | Off | Off | Off |
| Aftertouch: | 00 | Off | Off | Off |

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**VOICE DATA for the KEYBOARD SYNTHESIZER, as used in the
World Première Performance:**

Yamaha DX7

VOICE NAME: *Large Gong*

Created by: Ian Shanahan

Algorithm: 05

Feedback: 4

Key Transpose: E1

Pitch Modulation Sensitivity: 1

Oscillator Synchronization: On

| LFO: Wave | Speed | Delay | PMD | AMD | Sync |
|-----------|-------|-------|-----|-----|------|
| Sine | 16 | 83 | 12 | 06 | On |

| | Operator 1 | Operator 2 | Operator 3 | Operator 4 | Operator 5 | Operator 6 |
|--------------------------|------------|------------|------------|------------|------------|------------|
| Ampl. Mod. Sens.: | 0 | 0 | 0 | 1 | 0 | 0 |
| Mode: | Ratio | Ratio | Ratio | Ratio | Ratio | Ratio |
| Frequency: | 06.50 | 10.20 | 01.50 | 08.65 | 06.50 | 10.20 |
| Detune: | +3 | +4 | +1 | +0 | +2 | +7 |
| EG Rate 1: | 72 | 77 | 68 | 89 | 72 | 77 |
| EG Rate 2: | 26 | 25 | 39 | 00 | 26 | 25 |
| EG Rate 3: | 27 | 26 | 20 | 21 | 27 | 26 |
| EG Rate 4: | 32 | 18 | 26 | 27 | 32 | 18 |
| EG Level 1: | 99 | 99 | 99 | 99 | 99 | 99 |
| EG Level 2: | 68 | 69 | 86 | 99 | 68 | 69 |
| EG Level 3: | 00 | 00 | 00 | 00 | 00 | 00 |
| EG Level 4: | 00 | 00 | 00 | 00 | 00 | 00 |

Keyboard Level Scaling

| | | | | | | |
|---------------------------|------|------|------|------|------|------|
| Break Pt.: | A-1 | A-1 | A-1 | C3 | A-1 | A-1 |
| Curve L: | -LIN | -LIN | -LIN | -LIN | -LIN | -LIN |
| Curve R: | -LIN | -LIN | -LIN | -LIN | -LIN | -LIN |
| Depth L: | 00 | 00 | 00 | 09 | 00 | 00 |
| Depth R: | 00 | 00 | 00 | 00 | 00 | 00 |
| Kbd. Rate Scaling: | 4 | 4 | 0 | 2 | 4 | 4 |
| Op. Outpt. Level: | 99 | 74 | 90 | 99 | 99 | 73 |
| K. Velocity Sens.: | 4 | 4 | 4 | 4 | 4 | 4 |

Pitch EG

| | |
|-------------------|--------------------|
| Rate 1: 99 | Level 1: 50 |
| Rate 2: 99 | Level 2: 50 |
| Rate 3: 99 | Level 3: 50 |
| Rate 4: 99 | Level 4: 50 |

Poly/Mono: Poly

| | | |
|--------------------|--------------|-------------|
| Pitch Bend: | Range | Step |
| | 01 | 00 |

| | | | |
|--------------------|------------------|------------------|---------------------------------------|
| Portamento: | Mode | Glissando | Time |
| | Sus-Key P Retain | Off | 00, or 00 – 99 [optional variability] |

| | Range | Pitch | Amplitude | EG Bias |
|--------------------------|-------|-------|-----------|---------|
| Modulation Wheel: | 00 | Off | Off | Off |
| Foot Control: | 00 | Off | Off | Off |
| Breath Control: | 00 | Off | Off | Off |
| Aftertouch: | 00 | Off | Off | Off |

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**VOICE DATA for the KEYBOARD SYNTHESIZER, as used in the
World Première Performance:**

Yamaha DX7

VOICE NAME: *Dabachi 2*

Created by: Ian Shanahan

Algorithm: 29

Feedback: 5

Key Transpose: C3

Pitch Modulation Sensitivity: 1

Oscillator Synchronization: On

| LFO: Wave | Speed | Delay | PMD | AMD | Sync |
|-----------|-------|-------|-----|-----|------|
| Sine | 21 | 54 | 17 | 00 | On |

| | Operator 1 | Operator 2 | Operator 3 | Operator 4 | Operator 5 | Operator 6 |
|--------------------------|------------|------------|------------|------------|------------|------------|
| Ampl. Mod. Sens.: | 0 | 0 | 0 | 0 | 0 | 0 |
| Mode: | Ratio | Ratio | Ratio | Ratio | Ratio | Ratio |
| Frequency: | 02.00 | 03.14 | 02.00 | 03.46 | 02.00 | 03.46 |
| Detune: | -1 | +0 | +4 | -6 | +2 | -1 |
| EG Rate 1: | 86 | 61 | 77 | 80 | 77 | 80 |
| EG Rate 2: | 00 | 48 | 00 | 00 | 00 | 00 |
| EG Rate 3: | 39 | 41 | 40 | 36 | 40 | 36 |
| EG Rate 4: | 41 | 43 | 42 | 35 | 42 | 35 |
| EG Level 1: | 99 | 99 | 99 | 99 | 99 | 99 |
| EG Level 2: | 99 | 86 | 99 | 99 | 99 | 99 |
| EG Level 3: | 00 | 00 | 00 | 00 | 00 | 00 |
| EG Level 4: | 00 | 00 | 00 | 00 | 00 | 00 |

Keyboard Level Scaling

| | | | | | | |
|---------------------------|------|------|------|------|------|------|
| Break Pt.: | A-1 | A-1 | A-1 | A-1 | A-1 | A-1 |
| Curve L: | -LIN | -LIN | -LIN | -LIN | -LIN | -LIN |
| Curve R: | -LIN | -LIN | -LIN | -LIN | -LIN | -LIN |
| Depth L: | 00 | 00 | 00 | 00 | 00 | 00 |
| Depth R: | 00 | 00 | 00 | 00 | 00 | 00 |
| Kbd. Rate Scaling: | 0 | 0 | 0 | 0 | 0 | 0 |
| Op. Outpt. Level: | 99 | 87 | 99 | 70 | 99 | 70 |
| K. Velocity Sens.: | 4 | 4 | 4 | 4 | 4 | 4 |

Pitch EG

| | |
|-------------------|--------------------|
| Rate 1: 99 | Level 1: 50 |
| Rate 2: 99 | Level 2: 50 |
| Rate 3: 99 | Level 3: 50 |
| Rate 4: 99 | Level 4: 50 |

Poly/Mono: Poly

| | | |
|--------------------|--------------|-------------|
| Pitch Bend: | Range | Step |
| | 01 | 00 |

| | | | |
|--------------------|------------------|------------------|---------------------------------------|
| Portamento: | Mode | Glissando | Time |
| | Sus-Key P Retain | Off | 00, or 00 – 99 [optional variability] |

| | Range | Pitch | Amplitude | EG Bias |
|--------------------------|-------|-------|-----------|---------|
| Modulation Wheel: | 00 | Off | Off | Off |
| Foot Control: | 00 | Off | Off | Off |
| Breath Control: | 00 | Off | Off | Off |
| Aftertouch: | 00 | Off | Off | Off |

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**VOICE DATA for the KEYBOARD SYNTHESIZER, as used in the
World Première Performance:**

Yamaha DX7

VOICE NAME: *Dabachi 3*

Created by: Ian Shanahan

Algorithm: 32

Feedback: 2

Key Transpose: C2

Pitch Modulation Sensitivity: 1

Oscillator Synchronization: On

| LFO: Wave | Speed | Delay | PMD | AMD | Sync |
|-----------|-------|-------|-----|-----|------|
| Sine | 10 | 87 | 24 | 00 | On |

| | Operator 1 | Operator 2 | Operator 3 | Operator 4 | Operator 5 | Operator 6 |
|--------------------------|------------|------------|------------|------------|------------|------------|
| Ampl. Mod. Sens.: | 0 | 0 | 0 | 0 | 0 | 0 |
| Mode: | Ratio | Ratio | Ratio | Ratio | Ratio | Ratio |
| Frequency: | 04.00 | 04.00 | 09.87 | 09.87 | 09.87 | 04.00 |
| Detune: | +0 | -7 | +0 | +2 | -1 | +4 |
| EG Rate 1: | 72 | 77 | 77 | 73 | 75 | 75 |
| EG Rate 2: | 28 | 30 | 28 | 30 | 29 | 29 |
| EG Rate 3: | 34 | 31 | 33 | 30 | 32 | 32 |
| EG Rate 4: | 42 | 38 | 40 | 38 | 39 | 39 |
| EG Level 1: | 99 | 99 | 99 | 99 | 99 | 99 |
| EG Level 2: | 70 | 70 | 70 | 70 | 70 | 70 |
| EG Level 3: | 00 | 00 | 00 | 00 | 00 | 00 |
| EG Level 4: | 00 | 00 | 00 | 00 | 00 | 00 |

Keyboard Level Scaling

| | | | | | | |
|---------------------------|------|------|------|------|------|------|
| Break Pt.: | A-1 | A-1 | A-1 | A-1 | A-1 | A-1 |
| Curve L: | -LIN | -LIN | -LIN | -LIN | -LIN | -LIN |
| Curve R: | -LIN | -LIN | -LIN | -LIN | -LIN | -LIN |
| Depth L: | 00 | 00 | 00 | 00 | 00 | 00 |
| Depth R: | 00 | 00 | 00 | 00 | 00 | 00 |
| Kbd. Rate Scaling: | 4 | 4 | 2 | 2 | 2 | 4 |
| Op. Outpt. Level: | 99 | 99 | 99 | 99 | 99 | 99 |
| K. Velocity Sens.: | 4 | 7 | 4 | 4 | 7 | 4 |

Pitch EG

| | |
|-------------------|--------------------|
| Rate 1: 99 | Level 1: 50 |
| Rate 2: 99 | Level 2: 50 |
| Rate 3: 99 | Level 3: 50 |
| Rate 4: 99 | Level 4: 50 |

Poly/Mono: Poly

| | | |
|--------------------|--------------|-------------|
| Pitch Bend: | Range | Step |
| | 01 | 00 |

| | | | |
|--------------------|------------------|------------------|---------------------------------------|
| Portamento: | Mode | Glissando | Time |
| | Sus-Key P Retain | Off | 00, or 00 – 99 [optional variability] |

| | Range | Pitch | Amplitude | EG Bias |
|--------------------------|-------|-------|-----------|---------|
| Modulation Wheel: | 00 | Off | Off | Off |
| Foot Control: | 00 | Off | Off | Off |
| Breath Control: | 00 | Off | Off | Off |
| Aftertouch: | 00 | Off | Off | Off |

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**VOICE DATA for the KEYBOARD SYNTHESIZER, as used in the
World Première Performance:**

Yamaha DX7

VOICE NAME: *Dabachi 4*

Created by: Ian Shanahan

Algorithm: 05

Feedback: 4

Key Transpose: C3

Pitch Modulation Sensitivity: 1

Oscillator Synchronization: On

| LFO: Wave | Speed | Delay | PMD | AMD | Sync |
|-----------|-------|-------|-----|-----|------|
| Sine | 08 | 81 | 25 | 00 | On |

| | Operator 1 | Operator 2 | Operator 3 | Operator 4 | Operator 5 | Operator 6 |
|--------------------------|------------|------------|------------|------------|------------|------------|
| Ampl. Mod. Sens.: | 0 | 0 | 0 | 0 | 0 | 0 |
| Mode: | Ratio | Ratio | Ratio | Ratio | Ratio | Ratio |
| Frequency: | 02.00 | 03.14 | 02.00 | 03.14 | 02.00 | 03.14 |
| Detune: | +0 | -5 | -2 | +1 | +3 | -3 |
| EG Rate 1: | 32 | 40 | 66 | 67 | 67 | 70 |
| EG Rate 2: | 23 | 19 | 22 | 21 | 23 | 19 |
| EG Rate 3: | 28 | 28 | 25 | 32 | 28 | 28 |
| EG Rate 4: | 30 | 13 | 17 | 33 | 30 | 13 |
| EG Level 1: | 99 | 99 | 99 | 99 | 99 | 99 |
| EG Level 2: | 86 | 87 | 68 | 88 | 86 | 87 |
| EG Level 3: | 00 | 00 | 00 | 00 | 00 | 00 |
| EG Level 4: | 00 | 00 | 00 | 00 | 00 | 00 |

Keyboard Level Scaling

| | | | | | | |
|---------------------------|------|------|------|------|------|------|
| Break Pt.: | A-1 | A-1 | A-1 | A-1 | A-1 | A-1 |
| Curve L: | -LIN | -LIN | -LIN | -LIN | -LIN | -LIN |
| Curve R: | -LIN | -LIN | -LIN | -LIN | -LIN | -LIN |
| Depth L: | 00 | 00 | 00 | 00 | 00 | 00 |
| Depth R: | 00 | 00 | 00 | 00 | 00 | 00 |
| Kbd. Rate Scaling: | 4 | 4 | 7 | 4 | 4 | 4 |
| Op. Outpt. Level: | 90 | 76 | 99 | 77 | 99 | 78 |
| K. Velocity Sens.: | 7 | 7 | 4 | 4 | 4 | 4 |

Pitch EG

| | |
|-------------------|--------------------|
| Rate 1: 99 | Level 1: 50 |
| Rate 2: 99 | Level 2: 50 |
| Rate 3: 99 | Level 3: 50 |
| Rate 4: 99 | Level 4: 50 |

Poly/Mono: Poly

| | | |
|--------------------|--------------|-------------|
| Pitch Bend: | Range | Step |
| | 01 | 00 |

| | | | |
|--------------------|------------------|------------------|---------------------------------------|
| Portamento: | Mode | Glissando | Time |
| | Sus-Key P Retain | Off | 00, or 00 – 99 [optional variability] |

| | Range | Pitch | Amplitude | EG Bias |
|--------------------------|-------|-------|-----------|---------|
| Modulation Wheel: | 00 | Off | Off | Off |
| Foot Control: | 00 | Off | Off | Off |
| Breath Control: | 00 | Off | Off | Off |
| Aftertouch: | 00 | Off | Off | Off |

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**VOICE DATA for the KEYBOARD SYNTHESIZER, as used in the
World Première Performance:**

Yamaha DX7

VOICE NAME: *Dabachi 5*

Created by: Ian Shanahan

Algorithm: 31

Feedback: 4

Key Transpose: C2

Pitch Modulation Sensitivity: 1

Oscillator Synchronization: On

| LFO: Wave | Speed | Delay | PMD | AMD | Sync |
|-----------|-------|-------|-----|-----|------|
| Triangle | 19 | 91 | 18 | 00 | On |

| | Operator 1 | Operator 2 | Operator 3 | Operator 4 | Operator 5 | Operator 6 |
|--------------------------|------------|------------|------------|------------|------------|------------|
| Ampl. Mod. Sens.: | 0 | 0 | 0 | 0 | 0 | 0 |
| Mode: | Ratio | Ratio | Ratio | Ratio | Ratio | Ratio |
| Frequency: | 01.73 | 01.73 | 04.00 | 04.00 | 03.00 | 04.71 |
| Detune: | -3 | +7 | +3 | -6 | +3 | -2 |
| EG Rate 1: | 45 | 20 | 58 | 58 | 78 | 77 |
| EG Rate 2: | 40 | 46 | 00 | 65 | 31 | 32 |
| EG Rate 3: | 36 | 50 | 26 | 32 | 29 | 28 |
| EG Rate 4: | 42 | 42 | 30 | 36 | 31 | 30 |
| EG Level 1: | 99 | 68 | 99 | 99 | 99 | 99 |
| EG Level 2: | 67 | 40 | 99 | 72 | 68 | 69 |
| EG Level 3: | 00 | 00 | 00 | 00 | 00 | 00 |
| EG Level 4: | 00 | 00 | 00 | 00 | 00 | 00 |

Keyboard Level Scaling

| | | | | | | |
|---------------------------|------|------|------|------|------|------|
| Break Pt.: | A-1 | A-1 | A-1 | A-1 | A-1 | A-1 |
| Curve L: | -LIN | -LIN | -LIN | -LIN | -LIN | -LIN |
| Curve R: | -LIN | -LIN | -LIN | -LIN | -LIN | -LIN |
| Depth L: | 00 | 00 | 00 | 00 | 00 | 00 |
| Depth R: | 00 | 00 | 00 | 00 | 00 | 00 |
| Kbd. Rate Scaling: | 0 | 0 | 2 | 2 | 4 | 4 |
| Op. Outpt. Level: | 93 | 84 | 92 | 92 | 99 | 78 |
| K. Velocity Sens.: | 4 | 2 | 4 | 3 | 4 | 4 |

Pitch EG

| | |
|-------------------|--------------------|
| Rate 1: 99 | Level 1: 50 |
| Rate 2: 99 | Level 2: 50 |
| Rate 3: 99 | Level 3: 50 |
| Rate 4: 99 | Level 4: 50 |

Poly/Mono: Poly

| | | |
|--------------------|--------------|-------------|
| Pitch Bend: | Range | Step |
| | 01 | 00 |

| | | | |
|--------------------|------------------|------------------|---------------------------------------|
| Portamento: | Mode | Glissando | Time |
| | Sus-Key P Retain | Off | 00, or 00 – 99 [optional variability] |

| | Range | Pitch | Amplitude | EG Bias |
|--------------------------|-------|-------|-----------|---------|
| Modulation Wheel: | 00 | Off | Off | Off |
| Foot Control: | 00 | Off | Off | Off |
| Breath Control: | 00 | Off | Off | Off |
| Aftertouch: | 00 | Off | Off | Off |

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**VOICE DATA for the KEYBOARD SYNTHESIZER, as used in the
World Première Performance:**

Yamaha DX7

VOICE NAME: *Dabachi 6*

Created by: Ian Shanahan

Algorithm: 32

Feedback: 4

Key Transpose: C3

Pitch Modulation Sensitivity: 1

Oscillator Synchronization: On

| LFO: Wave | Speed | Delay | PMD | AMD | Sync |
|-----------|-------|-------|-----|-----|------|
| Triangle | 25 | 73 | 18 | 00 | On |

| | Operator 1 | Operator 2 | Operator 3 | Operator 4 | Operator 5 | Operator 6 |
|--------------------------|------------|------------|------------|------------|------------|------------|
| Ampl. Mod. Sens.: | 0 | 0 | 0 | 0 | 0 | 0 |
| Mode: | Ratio | Ratio | Ratio | Ratio | Ratio | Ratio |
| Frequency: | 03.14 | 03.46 | 03.14 | 03.46 | 02.00 | 02.00 |
| Detune: | +3 | +1 | -2 | -1 | -3 | +2 |
| EG Rate 1: | 73 | 80 | 73 | 80 | 70 | 77 |
| EG Rate 2: | 43 | 38 | 43 | 38 | 42 | 45 |
| EG Rate 3: | 32 | 29 | 32 | 29 | 42 | 39 |
| EG Rate 4: | 42 | 41 | 42 | 41 | 43 | 44 |
| EG Level 1: | 99 | 99 | 99 | 99 | 99 | 99 |
| EG Level 2: | 92 | 93 | 92 | 93 | 87 | 86 |
| EG Level 3: | 00 | 00 | 00 | 00 | 00 | 00 |
| EG Level 4: | 00 | 00 | 00 | 00 | 00 | 00 |

Keyboard Level Scaling

| | | | | | | |
|---------------------------|------|------|------|------|------|------|
| Break Pt.: | A-1 | A-1 | A-1 | A-1 | A-1 | A-1 |
| Curve L: | -LIN | -LIN | -LIN | -LIN | -LIN | -LIN |
| Curve R: | -LIN | -LIN | -LIN | -LIN | -LIN | -LIN |
| Depth L: | 00 | 00 | 00 | 00 | 00 | 00 |
| Depth R: | 00 | 00 | 00 | 00 | 00 | 00 |
| Kbd. Rate Scaling: | 0 | 0 | 0 | 0 | 0 | 0 |
| Op. Outpt. Level: | 99 | 87 | 99 | 88 | 99 | 99 |
| K. Velocity Sens.: | 4 | 4 | 4 | 4 | 4 | 4 |

Pitch EG

| | |
|-------------------|--------------------|
| Rate 1: 99 | Level 1: 50 |
| Rate 2: 99 | Level 2: 50 |
| Rate 3: 99 | Level 3: 50 |
| Rate 4: 99 | Level 4: 50 |

Poly/Mono: Poly

| | | |
|--------------------|--------------|-------------|
| Pitch Bend: | Range | Step |
| | 01 | 00 |

| | | | |
|--------------------|------------------|------------------|---------------------------------------|
| Portamento: | Mode | Glissando | Time |
| | Sus-Key P Retain | Off | 00, or 00 – 99 [optional variability] |

| | Range | Pitch | Amplitude | EG Bias |
|--------------------------|-------|-------|-----------|---------|
| Modulation Wheel: | 00 | Off | Off | Off |
| Foot Control: | 00 | Off | Off | Off |
| Breath Control: | 00 | Off | Off | Off |
| Aftertouch: | 00 | Off | Off | Off |

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Zodiac

Crystal Orbit Improvisations

α : Almost a whole breath-length; Rand {alternation of fluttertonguing and tongue-tremolo, normal articulation, "breath trills", air-flow (such that the given pitches are elicited)}

β : Rand {(multi)octave transposition, add material, (s)pace of events, silence, articulation (sputato, tongue-tremolo, fluttertonguing, normal, etc.), microtonal deviations, glissandi, vibrato, air-flow, multiphonics, admixture/withdrawal of vocal sounds, air-noise}

1 α β c.2''

2 α β c.5''

3 α β c.1''

4 α β c.4''

5 α β c.3''

6 α β c.6''

SOPRANO RECORDER

Ian Shanahan: **Zodiac: Crystal Orbit Improvisations** (1996)

1

7 α β c.1"

8 α β c.4"

9 α β c.2"

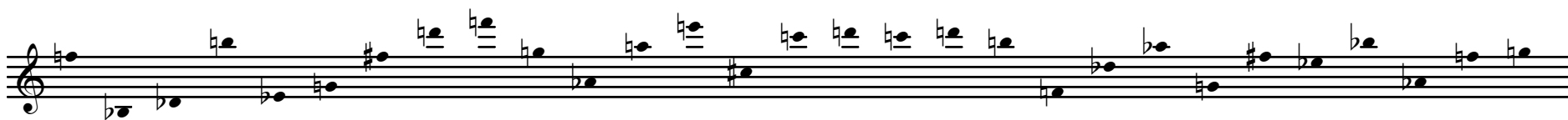
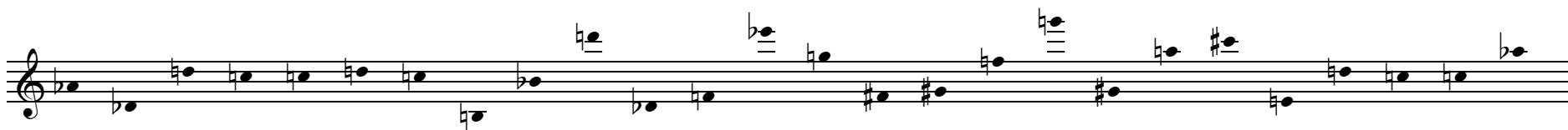
10 α β c.6"

11 α β c.3"

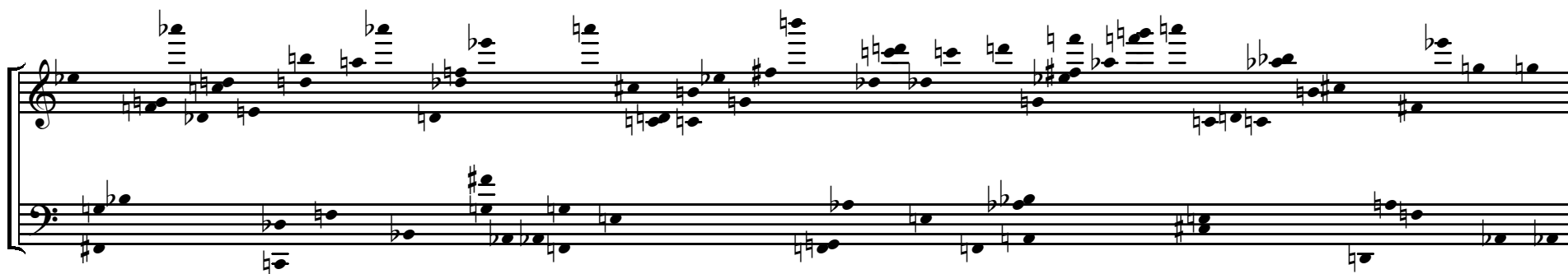
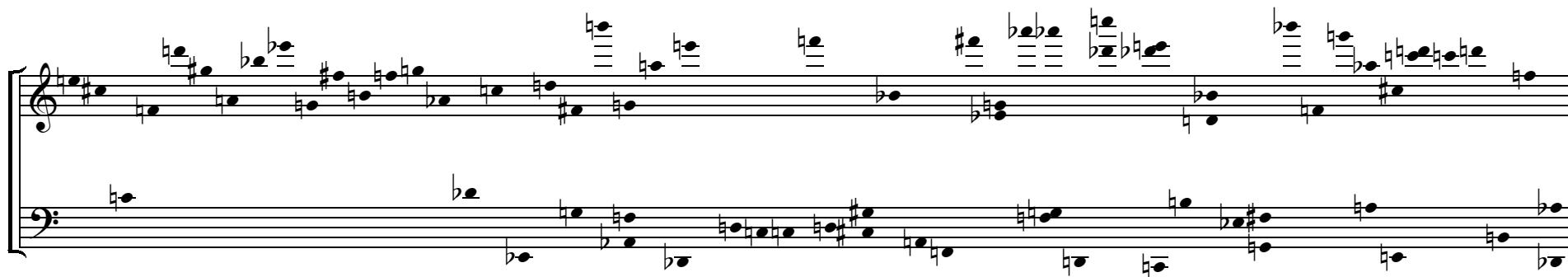
12 α β c.5"

Optional: Rand {glissandi (in both directions) between the given limits}

Rand {(multi)octave transposition, add material, (s)pacing of events, articulation (fluttertonguing, normal, etc.), microtonal deviations, portamento, pitch-bends, vibrato, air-flow}



Rand {(multi)octave transposition, add material, (s)pacing of events, texture (single tones, chords, grace-note(s), arpeggios, tremoli, ...), length of key-depression (staccatissimo to tenuto), key-velocity, sustaining pedal, volume pedal, pitch wheel, microtonal keyboard settings} Optional: Rand {portamento}



7.2 [P]S(T)ELLOR/MNÊME

7.2.1 ANALYTICAL NOTES

Prologue

My **[p]s(t)ellor/mnême** was commissioned (as its Programme Annotation declares), by Winsome Evans, especially for *The Renaissance Players'* Thirtieth Anniversary concert (entitled **Iberian Thesaurus**) – which was also to form part of the Eighth Sydney Spring International Festival of New Music, held during late 1997. Hence there were quite a number of compelling 'cultural challenges' for me to face while composing this piece:

1. Apart from **[p]s(t)ellor/mnême**, *The Renaissance Players'* **Iberian Thesaurus** concert was to consist of Spanish Sephardic music dating from the twelfth to the late fifteenth centuries. The sound-world and geometrical ground-plan of **[p]s(t)ellor/mnême** gracefully complements this music: the relatively beat-free nature of my new composition was in diametric contrast to the palpably beat-driven early Spanish music; yet **[p]s(t)ellor/mnême's** instrumentation, as well as its timbres and 'quadrivial preoccupations', clearly allude to Renaissance and Medieval practices.
2. *The Renaissance Players* group is largely comprised of improvising musicians who, mostly, are not specialists in the performance of late-twentieth-century music: the majority of them are not adept at reading (let alone interpreting) complex rhythmic formulas involving irrational 'tuplets', or at executing reliably so-called 'extended instrumental techniques' on period instruments. I thus decided to incorporate into **[p]s(t)ellor/mnême** certain explicit directives – 'randomized parameters' – that circumscribe the performative possibilities for extemporization. Moreover, I elected to omit any 'extended techniques' – although they may well arise spontaneously from my improvisatory options – and to score the whole piece in time-space notation (with each tone being sustained until the next sonority, wherever feasible). These compositional solutions allowed me to design an ornate proportionally self-similar structure for **[p]s(t)ellor/mnême**, without compromising in any way either my basic ideas for this work or its performers' musical abilities and experience.
3. For the sake of semiotic coherence, the iconology of **[p]s(t)ellor/mnême's** instrumentation itself needed to be taken into account. As was pointed out within section 1.2.9, recorders (and, as it happens, viola-da-gambas too) are traditionally

associated with death and things metaphysical – appropriately so, given that **[p]s(t)ellor/mnême** is written in memory of my father, James Owen Shanahan. Likewise, bells are often affiliated with ‘timeless eternity’ or ‘the sacred’, being suggestive of cosmic phenomena and thus of non-teleological cyclic constructs (such as one encounters in the ancient art of campanology, and in **[p]s(t)ellor/mnême** itself). I also intended my **[p]s(t)ellor/mnême** – in particular: its dark, murky tenth section – to stand as a late-twentieth-century analogue to the seventeenth-century funereal consort music of Henry Purcell or William Lawes, wherein viola-da-gambas do feature prominently. Further, the opening section of **[p]s(t)ellor/mnême** parades its pitch-materials in a mechanistic linear fashion – exactly as one would hear a carillon sounding off a scale of bell-tones before launching into its campanological permutations. **[p]s(t)ellor/mnême**’s eleventh and final section, however, is quite celestial – a kind of ‘occupation of the hereafter’ (connoted, perhaps, by the somewhat cloying timbres of bass viola-da-gamba double-stopped natural harmonics on gut strings) with my then recently departed father being portrayed throughout by the eerie, empty sounds of a waterphone.

The Soloist’s Part

The soprano recorder’s music from **[p]s(t)ellor/mnême** is composed of eleven “modules” – corresponding to **[p]s(t)ellor/mnême**’s eleven sections – the first ten of which are partitioned into $\langle \alpha \rangle$ and $\langle \beta \rangle$ materials (as within the soprano recorder part from **Zodiac: Crystal Orbit Improvisations**): i.e., volatile “fractalous sonorities” that merge into ordered sets of eighteen permutable pitch-classes, respectively. Indeed, so tightly are the recorder parts from **[p]s(t)ellor/mnême** and **Zodiac** interwoven that they both draw upon the very same cyclic group of permutations $\partial = \partial^1 = (3) (7, 16) (9, 11, 10) (13, 14, 15) (1, 18, 2, 17) (4, 12, 6, 5, 8)$, and ten of the former composition’s “modules” are absolutely identical to those from the latter work – aside from occasional octave transpositions:

| | | | | | | | | | | | |
|--------------------------------------|---|---|---|---|---|---|---|----|---|----|----|
| [p]s(t)ellor/mnême “modules”: | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
| Zodiac “modules”: | 1 | 2 | 4 | 5 | 6 | 7 | 8 | 11 | 3 | 12 | — |

The soprano recorder’s eleventh “module” from **[p]s(t)ellor/mnême** includes *only* $\langle \alpha \rangle$ -type sonorities, eleven in all, appropriated from **Zodiac: Crystal Orbit Improvisations**: within **[p]s(t)ellor/mnême**, they unfurl as follows (I refer here to their ordering within **Zodiac**) – 9th, 5th, 12th, 1st, 2nd, 11th, 4th, 8th, 6th, 7th, and (finally) **Zodiac**’s 3rd $\langle \alpha \rangle$ sonority.

We do begin to glimpse here the seeds of the principle of self-similarity: there are

eleven “modules” herein, with the last of them embracing exactly eleven sound-objects. Moreover, **[p]s(t)ellor/mnême**’s recorder part itself could be held to encapsulate the whole piece in microcosm, since at both of these levels, we perceive eleven self-contained sections which are themselves bifurcated (i.e. the recorder’s $\langle \alpha \rangle$ and $\langle \beta \rangle$ tones, being cast against a macroscopic backdrop of bell-peals that flow into a residue of other sounds); and the permutation ∂ , while acting directly upon the soprano recorder’s eighteen $\langle \beta \rangle$ pitch-classes, also serves as a preliminary template for macrostructural permutivity (in relation to the broken-consort music from **[p]s(t)ellor/mnême**).

In conclusion, as my Performance Notes to **[p]s(t)ellor/mnême** elucidate, the soloist’s part is not *rigidly* coordinated with the consort’s eleven sections: in essence, the soprano recorder’s music soars above that of the other instruments, ‘looping’ and embellishing its $\langle \beta \rangle$ materials until the handbells ring out again to announce the next section.

The Broken Consort’s Macroformal Proportionality

... it occurred to me that our basic unit of time (the second) is quite arbitrary, in that it does not stem from any easily discernible natural phenomena ... whereas some older units of length are directly related to the dimensions of the Earth itself. I was then astonished to learn that the Great Pyramid at Giza is a scaled-down representation of Earth’s northern hemisphere: the ratio of the Pyramid’s perimeter to its original height is very close to 2π ; this perimeter, when multiplied by 43,200, matches the Earth’s equatorial circumference to within a 1% error. The number 43,200 in turn derives, apparently, from Earth’s cycle of precession^{1b} (periodicity: 25,776 years).¹ Furthermore, the Giza Pyramids’ relative sizes and locations parallel the magnitudes and alignment of those stars which comprise the belt of the constellation Orion! Hence I asked myself: Could I not create something analogous – something as intellectually exquisite – with the chronomorphology of this new composition? To summarize, **[p]s(t)ellor/mnême** encompasses a notional duration of 332.28", partitioned internally according to certain well-known mathematical constants; these same constants are employed in an arcane way to yield 332.28" through a reiterative division of Earth’s 25,776-year precessional cycle. **[p]s(t)ellor/mnême** is, therefore, literally the Precession of the Equinoxes in microcosm – a ‘memory of stars’, insofar as cycles of precession are computed through long-term astronomical observation.²

So, given Earth’s precessional cycle of approximately 25,776 years and the fact that 1 [tropical] year \approx 365.2422 [solar] days, how many seconds constitute this diuturnity (which I shall label D)?

$$D \approx 60 \text{ seconds} \times 60 \text{ minutes} \times 24 \text{ hours} \times 365.2422 \text{ days} \times 25,776 \text{ years} \\ \approx 8.13411326638 \times 10^{11} \text{ seconds.}$$

To procure the notional duration of **[p]s(t)ellor/mnême** I then divided D, over and over again, by those archetypal geometric constants $\sqrt{2}$, $\sqrt{3}$, $\Phi = ((\sqrt{5} + 1) \div 2)$, π , and e . Regarding $\sqrt{2}$ and $\sqrt{3}$ in particular, it turns out that, symbolically,

... the primary Root Ratios such as $\sqrt{2}$ and $\sqrt{3}$ underlie the genesis of form in the natural world. In a Platonic sense, these primary “root *logoi*” are the sources of order in three-dimensional space yet, like the perfect Circle, do not have their existence in space or time. The early gnostics, in their elaborate cosmological myths, referred to such first principles as *Aeons* or “Eternities”, which are contained in the *Plérôma*, the “Fullness” [of God] or Treasury of Light. The material cosmos, which exists at a lower level of manifestation, is an emanation of the Aeons in the Pleroma. In his study of the esoteric gnostic books [such as the **Pistis Sophia** and **The Books of IEOU**], [Frederick] Bligh Bond saw that they contained a numerical symbolism, based on the “aeonial” root ratios of geometry. From this relationship, Bligh Bond concluded that Greek gematria is an expression of the eternal, aeonial relationships of a higher, extra-spatial order. As he states succinctly, “The Formative principles expressed by the mathematical powers One, Root Two, and Root Three, are assumed as the Aeons whose operation has been invoked to bring into manifestation the visible Universe. These may be said to determine the form of the Regular [Platonic] Solids and hence are fundamental”. ...³

... $\sqrt{3}$... [is] one of the most important mathematical constants in natural geometry, for it is the essential pattern of relation embodied in the perfect equilateral triangle [being its controlling ratio]. ... we see that an equilateral triangle with a half-base of 1 has a length of $\sqrt{3}$. Therefore, ... a rhombus with a width of 1 has a length of $\sqrt{3}$. Geometrically, both [equilateral] triangle and rhombus emerge from the *vesica piscis*, the “fish” shape described by two perfectly interpenetrating circles of the same size [each of whose centres lie upon the other circle’s perimeter].⁴

The iterative division of D by these five irrational numbers was accomplished through the divisor C, where

$$C = [(\pi \times \sqrt{2} \times e \times \Phi)^3 \times (\pi \times \sqrt{3} \times e \times \Phi)^4] = [18 \times \sqrt{2} \times (13 \times \Phi + 8) \times (\pi \times e)^7] \\ \approx 2448000300.$$

Therefore, we can now calculate the time-span, d, of **[p]s(t)ellor/mnême** itself:

$$d = D \div C \approx 332.2758278836".$$

The lengths of **[p]s(t)ellor/mnême**’s sections – and thus its macrostructural proportions – I elicited from the same five constants that yielded d from D; such an elegant ‘double derivation’ is decidedly unusual, contributing both to formal unity and to intensity of meaning (whereby **[p]s(t)ellor/mnême** is, truly, an ‘utterance of its name’). To be specific, d was segmented by various powers of $\sqrt{2}$, $\sqrt{3}$, Φ , π , and e (as well as their mirror-symmetrical, 1-aligned counterparts):⁵ after ‘normalization’ and several numerical experiments – carried out with the aim of breaking symmetry, so as to obtain an artistic proportionality – the result was –



– where

$$\begin{array}{lll}
 r_0 \equiv 0 & r_1 = \pi^{-2} & r_2 = (\sqrt{2})^{-5} = (4 \times \sqrt{2})^{-1} \\
 r_3 = 1 - (\sqrt{2})^{-1} & r_4 = 1 - \Phi^{-1} = 2 - \Phi & r_5 = 1 - (\sqrt{3})^{-1} \\
 r_6 = (\sqrt{3})^{-1} & r_7 = 1 - e^{-1} & r_8 = 1 - \pi^{-1} \\
 r_9 = 1 - \Phi^{-3} = 2 \times \Phi \div (2 \times \Phi + 1) & r_{10} = 1 - e^{-2} & r_{11} \equiv 1.
 \end{array}$$

Observe that my five generative constants are each employed here exactly twice; also, the midpoint of the segment FG is 0.5 (i.e. the midpoint of the whole, AL). Anyhow, the table below supplies all of the necessary data:

| Section * | Segment | Ratios ... $\times d =$ | Sectional Durations
(in seconds) † | Cumulative Durations
(in seconds: for the cymbal parts) |
|-----------|---------|-------------------------|---------------------------------------|--|
| 1 | AB | r_1 | $d_1 \approx 33.66658018''$ | $\approx 33.66658018''$ |
| 2 | BC | $r_2 - r_1$ | $d_2 \approx 25.07204260''$ | $\approx 58.73862278''$ |
| 3 | CD | $r_3 - r_2$ | $d_3 \approx 38.58271398''$ | $\approx 97.32133676''$ |
| 4 | DE | $r_4 - r_3$ | $d_4 \approx 29.59673585''$ | $\approx 126.9180726''$ |
| 5 | EF | $r_5 - r_4$ | $d_5 \approx 13.51821660''$ | $\approx 140.4362892''$ |
| 6 | FG | $r_6 - r_5$ | $d_6 \approx 51.40324946''$ | $\approx 191.8395387''$ |
| 7 | GH | $r_7 - r_6$ | $d_7 \approx 18.19884333''$ | $\approx 210.0383820''$ |
| 8 | HI | $r_8 - r_7$ | $d_8 \approx 16.47076492''$ | $\approx 226.5091469''$ |
| 9 | IJ | $r_9 - r_8$ | $d_9 \approx 27.32699829''$ | $\approx 253.8361452''$ |
| 10 | JK | $r_{10} - r_9$ | $d_{10} \approx 33.47103938''$ | $\approx 287.3071846''$ |
| 11 | KL | $1 - r_{10}$ | $d_{11} \approx 44.96864328''$ | $d \approx 332.2758278836'' \ddagger$ |

* NB: these section-numbers are *purely conceptual*, and shall be permuted by a cyclic group.

† Some approximate temporal coincidences are: $d_1 \equiv d_{10}$; $d_2 + d_5 \equiv d_3$; $d_4 \equiv d_9$.

‡ Apart from the waterphone's overhanging sounds, the cymbals' last clash terminates the work.

These well-ordered time-segments (which correspond to **[p]s(t)ellor/mnême's** *conceptual* sections) were then permuted to educe its *actual* sections – in the order that they are to be played in concert. As we shall see, the path leading to this permutation was quite long and tortuous:

[p]s(t)ellor/mnême's Cyclic Group of Permutations

Beyond the bipartite nature of the soloist's "modules" and their consort accompaniment (bell-peals resonating into other material), **[p]s(t)ellor/mnême's** cyclic group of permutations, $\langle \alpha \rangle$, serves to unite the macro- and microstructure of this piece through self-similarity. The genesis of $\langle \alpha \rangle$ itself may be traced back to my 1996 composition **Zodiac: Crystal Orbit Improvisations**, whose pitch-organization was largely governed by the cyclic group $\langle \partial \rangle$ stemming from the permutation $\partial = \partial^1 = (3) (7, 16) (9, 11, 10) (13, 14, 15) (1, 18, 2, 17) (4, 12, 6, 5, 8)$. Now clearly ∂ rearranges eighteen elements, whereas for **[p]s(t)ellor/mnême**, to start with I was interested in the re-ordering

potentialities of those eleven segments AB, BC, ... , JK, KL: it seemed obvious to choose a cyclic subgroup of ∂ that shuffled exactly eleven objects. So I began with the ‘subpermutation’ γ , where

$$\gamma = (7, 16) (1, 18, 2, 17) (4, 12, 6, 5, 8), \text{ by which } \gamma^{20} \equiv \gamma^0.$$

Within γ , however, the four numbers 12, 16, 17 and 18 are all greater than 11; furthermore, for purely musical reasons, I wanted the penultimate section of **[p]s(t)ellor/mnême** – that is, the tenth segment in whatever permutation of the *conceptual* sections 1, 2, ... , 10, 11 is settled upon – to have the longest time-span. Therefore, since d_6 is the biggest duration, we define the ambiguous permutation

$$\gamma^* = (1, A, 2, B) (4, 10, 6, 5, 8) (7, C), \text{ wherein } A, B \text{ and } C \text{ will be } 3, 9 \text{ or } 11.$$

Notice that 10 within γ^* replaces 12 within γ , because (irrespective of whatever A, B or C eventually become) the number 6 – which maps to d_6 , the duration of segment FG – shall then always occupy the tenth position in the permuted set of segments that ensues from γ^* being applied *once*. Now there are six distinct permutations of {A, B, C} – i.e. [A, B, C] = [3, 9, 11]; or [3, 11, 9]; or [9, 3, 11]; or [9, 11, 3]; or [11, 3, 9]; or [11, 9, 3]. I then focussed upon the four permutations γ^* , $(\gamma^*)^6$, $(\gamma^*)^{11}$ and $(\gamma^*)^{16}$, since these particular permutations exhaust all of the possibilities for deploying A, B and C such that the subset of numbers {4, 5, 6, 8, 10} remains fixed in the order [... , 10, 8, 5, ... , 4, ... , 6, ...] – with 6 always staying at the tenth position, as within γ^* :

| | | | | | | | | | | | |
|---------------------|---|---|---|----|---|---|---|---|---|----|----|
| $(\gamma^*)^0$: | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
| γ^* : | A | B | | 10 | 8 | 5 | C | 4 | | 6 | |
| $(\gamma^*)^6$: | 2 | 1 | | 10 | 8 | 5 | 7 | 4 | | 6 | |
| $(\gamma^*)^{11}$: | B | A | | 10 | 8 | 5 | C | 4 | | 6 | |
| $(\gamma^*)^{16}$: | 1 | 2 | | 10 | 8 | 5 | 7 | 4 | | 6 | |

So twenty-four options prevail: each of these four permutations embraces the six potential orderings for A, B, and C. The algebra of γ^* also dictates that the numbers 1, 2, 3, 7, 9 and 11 might hold the eleventh (and final) position – but musically, d_2 , d_7 and d_9 are rather too brief in comparison with d_6 , whereas d_{11} is too long. We are therefore left with only d_1 and d_3 as conceivable endings, which in turn narrows our field of twenty-four possible permutations down to just three:

$$\alpha = [3, 11, 2, 10, 8, 5, 9, 4, 7, 6, 1];$$

$$\Pi = [9, 11, 7, 10, 8, 5, 3, 4, 2, 6, 1]; \text{ and}$$

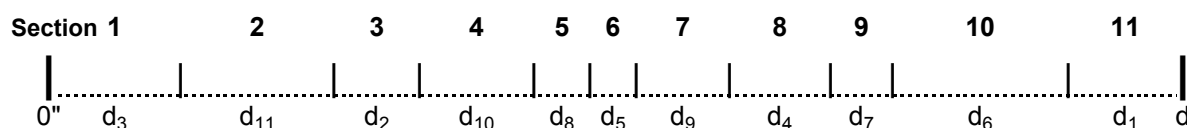
$$\Omega = [2, 1, 11, 10, 8, 5, 7, 4, 9, 6, 3].$$

In order literally to see and compare the manner in which these permutations would operate upon my preordained durations, I converted $d_1, d_2, \dots, d_{10}, d_{11}$ into physical lengths that reflected their relative proportions, drew these lengths upon a long strip of cardboard, numbered the resulting cardboard segments accordingly, and then sliced them apart. These eleven proportionalized cut-up segments were finally lined up in the numerical orderings that corresponded to α , \square , and Ω , so that I could instantly visualize the ensuing durational sequences at a sectional level: \square and Ω were soon rejected, because they both substantiated temporal progressions that to me seemed far too predictable; α alone betrayed no such *naïveté*, and so I deemed this permutation, α , best in terms of macroformal surprise or unexpectedness. Thus my ‘seed permutation’ for **[p]s(t)ellor/mnême** was at last decided upon:

$$\alpha = (7, 9) (1, 3, 2, 11) (4, 10, 6, 5, 8).$$

By analogy with the permutation γ , $\alpha^{20} \equiv \alpha^0$ – meaning that the cyclic group $\langle \alpha \rangle$ encapsulates twenty discrete permutations; moreover (just as one ought to expect from the cyclic structure of α), when $0 \leq k \leq 9$, α^k possesses a very similar ordering to α^{k+10} .

Anyway, now that α has been ascertained, we are ultimately in a position to ‘graph’ the *actual* (rather than the merely conceptual) macroproportionality of **[p]s(t)ellor/mnême**’s broken-consort music – of its ‘in-time’ sections:



The Cymbals’ Chronomorphology

It is primarily through its two cymbal parts – written for pairs of finger-cymbals (i.e. ‘hand crotales’) and small, thin clash-cymbals – that proportional (as well as permutational) self-similarity in **[p]s(t)ellor/mnême** is articulated across two adjacent structural planes. At the macrolevel, we have seen that the eleven ratios $(r_k - r_{k-1})$, $1 \leq k \leq 11$, determine all sectional spans; the same ratio-set, re-ordered by permutations from the cyclic group $\langle \alpha \rangle$, operates *within* each of this composition’s first ten sections: they are subdivided here exactly according to the segmentation of the whole piece. Indeed, the clang of cymbals resonates these subsectional proportions as ‘rhythms’ of various densities; in doing so, all of $\langle \alpha \rangle$ ’s twenty permutations α^m , $0 \leq m \leq 19$, are reified just once (including those cymbal clashes which mark the openings of each section):

Abbreviations: F = finger-cymbals; C = clash-cymbals.

| Sections (actual) | Permutations (each sectional pair is performed simultaneously) | |
|-------------------|---|--|
| 1 | F: $\alpha^0 = [1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11]$ | C: $\alpha^7 = [11, 3, 1, 6, 4, 8, 9, 10, 7, 5, 2]$ |
| 2 | F: $\alpha^1 = [3, 11, 2, 10, 8, 5, 9, 4, 7, 6, 1]$ | C: $\alpha^{12} = [1, 2, 3, 6, 4, 8, 7, 10, 9, 5, 11]$ |
| 3 | F: $\alpha^{15} = [11, 3, 1, 4, 5, 6, 9, 8, 7, 10, 2]$ | C: $\alpha^6 = [2, 1, 11, 10, 8, 5, 7, 4, 9, 6, 3]$ |
| 4 | F: $\alpha^{14} = [2, 1, 11, 8, 6, 10, 7, 8, 9, 4, 3]$ | C: $\alpha^5 = [3, 11, 2, 4, 5, 6, 9, 8, 7, 10, 1]$ |
| 5 | F: $\alpha^{16} = [1, 2, 3, 10, 8, 5, 7, 4, 9, 6, 11]$ | C: $\alpha^2 = [2, 1, 11, 6, 4, 8, 7, 10, 9, 5, 3]$ |
| 6 | F: $\alpha^{19} = [11, 3, 1, 8, 6, 10, 9, 5, 7, 4, 2]$ | C: $\alpha^8 = [1, 2, 3, 5, 10, 4, 7, 6, 9, 8, 11]$ |
| 7 | F: $\alpha^4 = [1, 2, 3, 8, 6, 10, 7, 5, 9, 4, 11]$ | C: $\alpha^{13} = [3, 11, 2, 5, 10, 4, 9, 6, 7, 8, 1]$ |
| 8 | F: $\alpha^{18} = [2, 1, 11, 5, 10, 4, 7, 6, 9, 8, 3]$ | C: $\alpha^{11} = [11, 3, 1, 10, 8, 5, 9, 4, 7, 6, 2]$ |
| 9 | F: $\alpha^9 = [3, 11, 2, 8, 6, 10, 9, 5, 7, 4, 1]$ | C: $\alpha^3 = [11, 3, 1, 5, 10, 4, 9, 6, 7, 8, 2]$ |
| 10 | F: $\alpha^{10} = [2, 1, 11, 4, 5, 6, 7, 8, 9, 10, 3]^*$ | C: $\alpha^{17} = [3, 11, 2, 6, 4, 8, 9, 10, 7, 5, 1]^*$ |
| 11 | TACET (except for beginning- and end-clashes, and the <i>macro</i> α^0) | |

* NB: this pair of permutations for section 10 was chosen on account of their ordinal similarity to those from section 1 (due to the closeness of ordering between α^h and α^{h+10} , $0 \leq h \leq 9$) – so as to engender a vaguely perceptible ‘recapitulation’.

As before, my proportionalized strips of cardboard came in very handy during the process of pairing off permutations whose duration-sets counterpoint against each other attractively. Moreover, and most importantly, the two cymbal parts in **[p]s(t)ellor/mnême** also delineate a kind of ‘ghost structure’ – of **[p]s(t)ellor/mnême**’s macroformal proportions unfurling in their *original* ordering $\alpha^0 = [1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11]$; that is to say, my initial, “conceptual” sectionality is itself expressed acoustically, and one can trace its vestiges (which are embedded within the self-similarities) back to those relatively few synchronized clashes that take place strictly between sectional boundaries.⁶ Finally, the cymbal music in **[p]s(t)ellor/mnême** flaunts a cultivated ‘statistical symmetry’: within all twenty permutations α^m , $0 \leq m \leq 19$, there are just four equivalence classes of opening-sequences (due to the cycle (1, 3, 2, 11) within α) – $[1, 2, 3, \dots]$, $[2, 1, 11, \dots]$, $[3, 11, 2, \dots]$, and $[11, 3, 1, \dots]$; their number of occurrences, set out below, is mirrored precisely between the finger-cymbals and clash-cymbals:

| Permutation openings: | [1, 2, 3, ...] | [2, 1, 11, ...] | [3, 11, 2, ...] | [11, 3, 1, ...] |
|-----------------------|-----------------------|------------------------|------------------------|------------------------|
| finger-cymbals: | ×3 | ×3 | ×2 | ×2 |
| clash-cymbals: | ×2 | ×2 | ×3 | ×3 |

The Handbells’ Changes

For the sake of maximizing structural unity, the permutational morphology of the two handbell parts is strikingly homologous to that of the cymbals’: all of **[p]s(t)ellor/mnême**’s eleven sections commence with a handbell-peal consisting of eleven attacks per player (wherein each of the sixteen bells is struck *exactly twice*, with only the first attack of every peal being strictly synchronous);⁷ as with the cymbals, miscellaneous permutations from

< α > ‘ring the changes’, whereby the order of bell-tones at the start of the work was designated as α^0 :

| | $\alpha^0 = 1$ | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---------------------|----------------------------|-----------------------------|--------------|--------------|----------------------------|-----------------------------|-----------------------------|-----------------------------|-------------|----------------------------|-----------------------------|
| handbells 1: | B \flat 4
E \flat 4 | C \flat 5 | A \flat 5 | C \sharp 5 | E \flat 5
F \flat 4 | D \flat 5 | E \flat 4 | A \flat 5
C \flat 5 | B \flat 4 | E \flat 5
D \flat 5 | C \sharp 5
F \flat 4 |
| handbells 2: | A \flat 2
G \flat 2 | B \flat 3
G \sharp 3 | F \sharp 3 | C \flat 3 | D \flat 3 | B \flat 3
C \sharp 3 | F \sharp 3
G \flat 2 | G \sharp 3
A \flat 2 | D \flat 3 | C \sharp 3 | C \flat 3 |
| | $\alpha^0 = 1$ | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |

So, given α^0 , the permutations from < α > that lie behind these campanological changes are:

| Sections (actual) | Handbells 1: Permutations | Handbells 2: Permutations |
|-------------------|---|---|
| 1 | $\alpha^0 = [1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11]$ | $\alpha^0 = [1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11]$ |
| 2 | $\alpha^1 = [3, 11, 2, 10, 8, 5, 9, 4, 7, 6, 1]$ | $\alpha^7 = [11, 3, 1, 6, 4, 8, 9, 10, 7, 5, 2]$ |
| 3 | $\alpha^7 = [11, 3, 1, 6, 4, 8, 9, 10, 7, 5, 2]$ | $\alpha^5 = [3, 11, 2, 4, 5, 6, 9, 8, 7, 10, 1]$ |
| 4 | $\alpha^2 = [2, 1, 11, 6, 4, 8, 7, 10, 9, 5, 3]$ | $\alpha^{10} = [2, 1, 11, 4, 5, 6, 7, 8, 9, 10, 3]$ |
| 5 | $\alpha^5 = [3, 11, 2, 4, 5, 6, 9, 8, 7, 10, 1]$ | $\alpha^{13} = [3, 11, 2, 5, 10, 4, 9, 6, 7, 8, 1]$ |
| 6 | $\alpha^{15} = [11, 3, 1, 4, 5, 6, 9, 8, 7, 10, 2]$ | $\alpha^3 = [11, 3, 1, 5, 10, 4, 9, 6, 7, 8, 2]$ |
| 7 | $\alpha^{17} = [3, 11, 2, 6, 4, 8, 9, 10, 7, 5, 1]$ | $\alpha^1 = [3, 11, 2, 10, 8, 5, 9, 4, 7, 6, 1]$ |
| 8 | $\alpha^{10} = [2, 1, 11, 4, 5, 6, 7, 8, 9, 10, 3]$ | $\alpha^8 = [1, 2, 3, 5, 10, 4, 7, 6, 9, 8, 11]$ |
| 9 | $\alpha^8 = [1, 2, 3, 5, 10, 4, 7, 6, 9, 8, 11]$ | $\alpha^6 = [2, 1, 11, 10, 8, 5, 7, 4, 9, 6, 3]$ |
| 10 | $\alpha^{11} = [11, 3, 1, 10, 8, 5, 9, 4, 7, 6, 2]$ | $\alpha^{19} = [11, 3, 1, 8, 6, 10, 9, 5, 7, 4, 2]$ |
| 11 | $\alpha^{12} = [1, 2, 3, 6, 4, 8, 7, 10, 9, 5, 11]$ | $\alpha^{16} = [1, 2, 3, 10, 8, 5, 7, 4, 9, 6, 11]$ |

Within the cyclic group < α >, we have already recognized that there are four equivalence classes of permutational opening-gambits (highlighted in bold-face type above); their pairwise combinations here were all settled upon *before* any specific permutations were chosen. And, just like the cymbals’ permutational recapitulation, the identity of equivalence classes in the bell-peals of the first and last sections ‘closes the mandalikonic circle’. It is also a felicitous statistical coincidence that both of the handbell parts call for each type of permutational opening not less than twice – in a holographic analogue to the dual sounding of every handbell within each peal. However, not every permutation from < α > manifests itself within the handbell music; in fact, four of < α >’s twenty permutations are completely absent from it, while certain others materialize twice:

| | | | | | | | | | | |
|--|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|
| Permutation from <α>: | α^0 | α^1 | α^2 | α^3 | α^4 | α^5 | α^6 | α^7 | α^8 | α^9 |
| Handbells’ Usage: | x2 | x2 | x1 | x1 | — | x2 | x1 | x2 | x2 | — |
| Permutation from <α>: | α^{10} | α^{11} | α^{12} | α^{13} | α^{14} | α^{15} | α^{16} | α^{17} | α^{18} | α^{19} |
| Handbells’ Usage: | x2 | x1 | x1 | x1 | — | x1 | x1 | x1 | — | x1 |

[p]s(t)ellor/mnême's Macrostructure: Its Instrumentational Signature

... Like the sacred Buddhist *mandalas* or the *ikons* of Orthodox Christianity, [[p]s(t)ellor/mnême] is a static object which exists solely to be contemplated – a 'stuttering memory' that recapitulates data inexorably: here, the same gesture is repeatedly 're-perspectivized', somewhat as one might examine from various angles the facets of a jewel. (Such works of mine I now refer to as "mandalikons".) ...⁸

What, then, is this musical "gesture" that is "repeatedly 're-perspectivized'"? It is straightforwardly bifid – peals of handbells, out of which emerge variegated orchestrational filterings of recurrent sonic data – and constitutes the elementary formal substrate for this piece; most evidently, its perspectival reorientations from section to section have been effectuated through shifts in instrumentation, sound-colour, texture, and density. The following tabulation (which I have lifted directly from [p]s(t)ellor/mnême's sketches) adequately captures the situation:

Abbreviations: G = bass viola-da-gambas; H = Celtic harp; M = mandola; R = alto rebec. NB: G and H can readily play monodic or chordal musics, whereas M and R are considered herein to be essentially monodic.

| Section (actual) | Handbells' dynamics | Instruments with handbells | (Pitched) Consort Instruments after the Handbell-Peals; Further Comments |
|--|---------------------|---|---|
| 1 | <i>ff</i> | GHMR {tutti}
H & M <i>f</i> poss. | GHMR {tutti}
Material is presented in the manner of a campanologist's scalic opening peal. The 'simultaneities' of G & H overlap scale-patterns. |
| 2 | <i>fff</i> | HM
H has fast <i>gliss.</i> ,
<i>f</i> poss. | SILENCE!
Just the soloist, the cymbals, and resonances from the handbells, etc. |
| 3 | <i>f</i> | H
<i>f</i> poss. | GR {no H or M} – "bowed" mostly
G – single natural harmonics only, straddled by isolated <i>pizzicati</i> (to bring about some timbral counterpoint);
R – rapid notes, then sustained; harmonically important at times. |
| 4 | <i>ff</i> | GHR | H {only} – "plucked" {no M}
NB: some <i>glissandi</i> ; otherwise just single tones and chords (which may be broken up by the harpist in various ways). |
| 5 | <i>f</i> | GHM {no R} | GMR {no H} – "rebec solo" (since the others are pluckers)
G – <i>pizzicato</i> only, except for their last event (viz. bowed natural harmonics, composed first). |
| 6 | <i>f</i> | HMR
H <i>f</i> poss.; M <i>f</i> | GHMR {tutti} |
| 7 | <i>ff</i> | HM
H & M both <i>f</i> poss. | HM – "plucked" {no G or R} |
| 8 | <i>ff</i> | GR {no H} | HMR {no G} – "rebec solo" (since the others are pluckers)
R – harmonically important. |
| 9 | <i>f</i> | GHM {no R}
H <i>f</i> poss.; M <i>f</i> | SILENCE! – as in section 2 {no G} |
| 10 | <i>fff</i> | SILENCE! | GHMR {tutti} – "STASIS, funereal" |
| 11 | <i>mp!</i> | GHM {no R}
H & M both <i>mp</i>
G – harms. only | G – "bowed"
A counterpoint of double-stopped natural harmonics, including fairly continuous ethereal caresses from the waterphone. |
| Insts. with the handbells: Combinations * | | | Insts. after the handbells: Combinations – Statistics * |
| Silence, H, GR, GHR, HMR, & GHMR × 1;
HM × 2;
GHM × 3. | | | G, H, GR, HM, GMR, & HMR × 1;
Silence × 2;
GHMR × 3. |

* eight out of the sixteen possible instrument-combinations are employed *with* and *after* the handbells; likewise, each type of instrument plays in exactly six sections (a delightful symmetry which I prefigured).

The Broken Consort's Sets of "Objects"

In **[p]s(t)ellor/mnême**, each well-pitched consort instrument casts a *fixed set* of "objects" – i.e. individual sonorities – whereby, for every section that requires the instrument, the entire "object"-set (or some subset thereof)⁹ recurs, over and over again; yet texture, pacing, and the order in which the "objects" themselves unfold each time, have all been variegated throughout. Just like the elements of a metal windchime, all sets of "objects" are absolutely immutable, and comprise the raw pitch-material of this piece. Within each section, I am responsible for its 'space' (its duration and density-profile) as well as its underlying 'magnetic field' (the pitch-distribution and flow); the instrumentalists themselves are invited to fine-tune musical details through their 'randomized parameters'. Hence the 'stuttering memory' insinuated by my title **[p]s(t)ellor/mnême** alludes not only to the recapitulatory gesture (of handbell-peals thence 'instrumental residue'), but also to this residue's rigidly closed sets of micro-elements: therein, no 'foreign matter' is ever permitted to intrude.

My approach to the broken consort's sets of "objects" was quintessentially statistical. In constructing each of **[p]s(t)ellor/mnême**'s sections, my self-imposed rule – that once an "object" had been deployed, it could not be repeated therein – certainly led to some very stimulating compositional quandaries: if I privileged certain "objects" over others (as harmonic or timbral 'favourites', say) and disposed them first of all within a section, then the remainder often became ever more intractable; and yet this circumstance did seem to bring about the salutary effect of promoting variety amongst **[p]s(t)ellor/mnême**'s musical vocabularies. The table below outlines (in general terms) the nature of each instrument's set of "objects", after which – by way of a concrete example – I shall furnish a fully detailed account of the mandola's set of "objects":

| Instruments | Objects' totals | The Breakdown of "Objects" |
|--------------------|------------------------|---|
| mandola | 43 | 16 natural harmonics; 25 ordinary single tones (strings 1–4: 6 + 6 + 7 + 6);
plucking behind the bridge (once) and behind the nut (once) |
| Celtic harp | 37 | 30 single tones; 6 chords (adjuncts of certain handbell sonorities); 1 glissando |
| alto rebec | 32 | 32 single tones (strings I–III: 10 + 11 + 11) |
| bass viol 1 | 38 | 15 double-stopped natural harmonics; 9 ordinary double-stops; 14 single tones,
which include every open string (strings I–VI: 4 + 2 + 2 + 2 + 2 + 2) |
| bass viol 2 | 38 | 17 double-stopped natural harmonics; 5 ordinary double-stops; 16 single tones,
which include every open string (strings I–VI: 4 + 3 + 3 + 2 + 2 + 2) |
| bass viol 3 | 38 | 16 double-stopped natural harmonics; 8 ordinary double-stops; 14 single tones,
which include every open string (strings I–VI: 4 + 2 + 2 + 2 + 2 + 2) |

(Recalling that **[p]s(t)ellor/mnême** was composed in memory of my father, who died during July 1997 in his seventy-fifth year, the sums of certain "object"-set cardinalities are quite intentionally symbolic: 43 + 32 = 37 + 38 = 75.)

The Mandola's Forty-Three "Objects" – Actual Pitches

| | | | | | | | | | | |
|-------------------|----------------------------|----------------------------|----------------------------|--------------|----------------------------|----------------------------|----------------------------|----------------------------|----------------------------|----------------------------|
| Object: 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
| nut str. | bridge str. | A \flat 1 | B \flat 1 | D \flat 2 | D \natural 2 | D \natural 2 | E \natural 2 | E \natural 2 | G \natural 2
harmonic | G \sharp 2 |
| Object: 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 |
| A \natural 2 | A \sharp 2 | B \natural 2 | C \natural 3 | C \sharp 3 | D \flat 3 | D \natural 3
harmonic | D \natural 3
harmonic | D \sharp 3 | E \natural 3 | F \natural 3 |
| Object: 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 | 33 |
| F \sharp 3 | G \natural 3 | G \natural 3 | G \natural 3
harmonic | A \flat 3 | A \natural 3
harmonic | A \natural 3
harmonic | A \natural 3 | B \flat 3 | B \natural 3
harmonic | D \natural 4
harmonic |
| Object: 34 | 35 | 36 | 37 | 38 | 39 | 40 | 41 | 42 | 43 | |
| D \natural 4 | E \natural 4
harmonic | E \natural 4
harmonic | F \sharp 4
harmonic | F \sharp 4 | A \natural 4
harmonic | B \natural 4
harmonic | D \flat 5
harmonic | E \natural 5
harmonic | G \sharp 5
harmonic | |

Epilogue

Throughout the 1980s – as a young composer (of Anglo-Irish background) living and working in Sydney, Australia who was then being steeped in a mind-bogglingly immense array of Western, non-Western and new musics ... and who was also thinking about his potential audiences – I began to interrogate certain aspects of the venerable European art-music tradition: Must my music *a/ways* evince a dramatic structure? At a macroscopic level must it also be goal-directed? These composerly questions still resonate with me. Increasingly, however, I am convinced that teleology and a clear-cut dramatic arch are *not* necessary conditions for my – or, indeed, anyone else's – music; the two "mandalikons" within **A World of Becoming** epitomize my quite (self-)conscious attempts to purge such well-worn features from my work.

Let the intelligent listener be the judge...

ENDNOTES

1. This point is fleshed out in Hancock (1995), pp.459–461.

On the significance of 43,200, Graham Hancock – *ibid.*, pp.460–461 – writes that “... it is therefore necessary to ask whether there is anything else in the data which might confirm that the ratio of 1:43,200 is a purposeful expression of intelligence and knowledge, rather than some numerical fluke. The ratio itself seems to provide that confirmation, for the simple reason that 43,200 is *not* a random number ... On the contrary it is one of a series of numbers, and multiples of those numbers, which relate to the phenomenon of precession of the equinoxes, and which have become embedded in archaic myths all around the world. ... the basic numerals of the Pyramid/Earth ratio crop up again and again in those myths, sometimes directly as 43,200 sometimes as 432, as 4,320, as 432,000, as 4,320,000, and so on. What we appear to be confronted by are two remarkable propositions, back-to-back, as though designed to reinforce one another. It is surely remarkable enough that the Great Pyramid should be able to function as an accurate scale-model of the northern hemisphere of planet earth. But it is even more remarkable that the *scale involved* should incorporate numbers relating precisely to one of the key planetary mechanisms of the earth. This is the fixed and apparently eternal precession of its axis of rotation around the pole of the ecliptic, a phenomenon which causes the vernal point to migrate around the band of the zodiac at the rate of one degree every 72 years, and 30 degrees (one complete zodiacal constellation) every 2,160 years. Precession through two zodiacal constellations, or 60 degrees along the ecliptic, takes 4,320 years. The constant repetition of these precessional numbers in ancient myths could, perhaps, be a coincidence. Viewed in isolation, the appearance of the precessional number 43,200 in the pyramid/earth ratio might also be a coincidence (although the odds against this must be astronomical). But when we find precessional numbers in *both* these very different media – the ancient myths and the ancient monument – it really does strain credulity to suppose that coincidence is all that is involved here. Moreover, just as the Teutonic myth of Valhalla’s walls leads us to the precessional number 432,000 by inviting us to *calculate* the [number of] warriors who ‘go to war with the Wolf’ (500 plus 40 [all] multiplied by 800, ...), so the Great Pyramid leads us to the precessional number 43,200 by demonstrating through the *pi* relationship that it might be a scale-model of the earth and then by inviting us to *calculate* that scale. ...”

- 1b. For readers with scanty knowledge of astronomy (let alone celestial mechanics), *precession* – according to ed. Ridpath (1979), p.159 – is a “slow wobbling of the Earth on its axis, like the wobble of a spinning top whose axis is not upright, but far slower. The net effect is to change the part of the sky at which the Earth’s axis points. ... Precession is caused by the gravitational pulls of the Moon and Sun on the Earth’s slight equatorial bulge. This bulge arises because of the Earth’s rotation; the planet’s equatorial diameter is about 26 miles (42 km) greater than its polar diameter. The Earth’s equator, and hence also the bulge, is inclined at about 23.5° to the plane of the Earth’s orbit (the *ecliptic*); the Sun and Moon pull on the bulge, as if to tilt our planet back to the vertical. But instead of tilting upright, the Earth’s axis swings in a cone-shaped motion, still at 23.5° to the vertical; neither the tilt of the Earth’s axis, nor the position of the poles on the globe, is changed by precession. The Earth’s axis takes about 26,000 years to swing around once; this is called a *cycle of precession*. During each cycle of precession the Earth’s poles trace out a circle on the sky. Precession therefore slowly changes the position of the celestial poles. Although Polaris is the [north] pole star today, in [about] 12,000 years the pole will have drifted near to Vega. The changing orientation of the Earth with respect to the stars affects the positioning against the star background of the *equinoxes*, the points at which the Earth’s equator intersects the ecliptic (the plane of the Earth’s orbit). The equinoxes slide once around the sky every 26,000 years, in what is termed the *precession of the equinoxes*; the equinoxes move about 50 seconds of arc westward against the star background each year. Precession also shifts the star coordinates known as right ascension and declination; this is why star positions are always given for a certain *epoch*, or reference date (currently 1950 or 2000). A [summer] constellation such as Orion will be seen in the [winter] skies after half a cycle of precession. The seasons will not be affected, however, because our calendar is based on the movement of the Sun, and the first day of northern spring will always fall around March 21 (the spring equinox). The spring equinox lay in the constellation of Aries 2,000 years ago, and is still referred to as the First Point of Aries. However, precession has now moved it into the constellation of Pisces, and it will reach the constellation of Aquarius in about 600 years. So the much-heralded Age of Aquarius will not be with us for some time yet”.
2. **[p]s(t)ellor/mnême**, Programme Annotation.
3. Fidler (1993), pp.76–77.
4. *ibid.*, p.70.

5. This terminology, concerning proportional ‘alignment’, was explained at the opening of section 1.2.4.
6. These attack-points were tabulated earlier in this section, as “Cumulative Durations”.
7. One cannot ignore the conspicuous ‘elevenness’ here (i.e. the self-similarity of eleven puncta): eleven sections, all launched by an onslaught of bell-sounds; eleven attacks within each peal.
8. **[p]s(t)ellor/mnême**, Programme Annotation.
9. Beyond my omission of certain instruments from certain sections (as a form-clarifying device), the use of smaller *subsets* of “objects” is a further filtering process within **[p]s(t)ellor/mnême**.

Ian Shanahan (1997)

– *In Memoriam James Owen Shanahan (25/9/1922 – 8/7/1997)*

To Winsome Evans;
For The Renaissance Players' 30th anniversary:

~~~~~

# *[p]s(t)ellor/mnême*

a mandalikon

for

soprano recorder

and

a broken consort of early-music instruments

~~~~~

PROGRAMME ANNOTATION

[p]s(t)ellor/mnême

a mandalikon
for soprano recorder and a broken consort of early-music instruments

Ian Shanahan (1997)

Although not always grammatically accurate, the following linguistic homologies apply:

mnême [Greek] ≈ memory (whence 'mnemonic');

psellor [Greek] ≈ stuttering, recursion;

stellor [Latin] ≈ of stars (whence 'stellar').

So ... **[p]s(t)ellor/mnême** ≈ 'stuttering memory; memory of stars', this being my second composition thus far to embrace total non-teleology. Like the sacred Buddhist *mandalas* or the *ikons* of Orthodox Christianity, it is a static object which exists solely to be contemplated – a 'stuttering memory' that recapitulates data inexorably: here, the same gesture is repeatedly 're-perspectivized', somewhat as one might examine from various angles the facets of a jewel. (Such works of mine I now refer to as "mandalikons".)

How is **[p]s(t)ellor/mnême** a 'memory of stars'? Firstly, it occurred to me that our basic unit of time (the second) is quite arbitrary, in that it does not stem from any easily discernible natural phenomena ... whereas some older units of length-measurement are geodetic, being directly related to the dimensions of the Earth itself. I was then astonished to learn that the Great Pyramid at Giza is a scaled-down representation of Earth's northern hemisphere: the ratio of the Pyramid's perimeter to its original height is very close to 2π ; this perimeter, when multiplied by 43,200, matches the Earth's equatorial circumference to within a 1% error. The number 43,200 in turn derives, apparently, from Earth's cycle of precession (periodicity: 25,776 years).^{*} Furthermore, the Giza Pyramids' relative sizes and locations parallel the magnitudes and alignment of those stars which comprise the belt of the constellation Orion! Hence I asked myself: Could I not create something analogous – something just as intellectually exquisite – with the chronomorphology of this new composition? To summarize, **[p]s(t)ellor/mnême** encompasses a notional duration of 332.28", partitioned internally according to certain well-known mathematical constants; these same constants are employed in a rather arcane way to yield 332.28" through a reiterative division of Earth's 25,776-year precessional cycle. **[p]s(t)ellor/mnême** is, therefore, literally the Precession of the Equinoxes in microcosm – a 'memory of stars', insofar as cycles of precession are computed through long-term astronomical observation.

Since I am one of several composers who has been an occasional member of The Renaissance Players, Winsome Evans commissioned **[p]s(t)ellor/mnême** from me as part of the group's thirtieth anniversary celebrations. But perhaps there is also a tenuous connection (because of my 'stellar' title and quadrivial preoccupations) to The Renaissance Players' Spanish Mediaeval repertoire – Santiago de Compostela? In any case, I dedicate this festschrift piece to Winsome, from whom I shall always continue to learn, with the greatest respect and thanks.

It is equally appropriate, given the title's fabricated meaning, that **[p]s(t)ellor/mnême** be written in memory of my father, Jim Shanahan (25/9/1922 – 8/7/1997): in life, he certainly burned bright as a star. (Who knows? The Old Man might have even liked this piece!)

^{*} see Graham Hancock: **Fingerprints of the Gods** (Mandarin Paperbacks, London, 1995), pp.459–461.

[p]s(t)ellor/mnême was premièred – and broadcast live across Australia on ABC Classic FM radio – by Ian Shanahan (soprano recorder) and The Renaissance Players (Nick Wales, Eleanor Lewis, Cathy Tabrett, Jenny Ericksson, Kim Poole, Winsome Evans, Andrew Lambkin, Sally Treloyn, Barbara Stackpool, Tim Chung, and Simon Lobelson), during the Eighth Sydney Spring International Festival of New Music, Eugene Goossens Hall, ABC Centre, Harris Street, Ultimo, Sydney, on 19 September 1997.

The composer received the inaugural **Sydney Spring Award for Composition**, for the most outstanding original Australian composition **{[p]s(t)ellor/mnême}** performed during the Eighth Sydney Spring International Festival of New Music (1997). **[p]s(t)ellor/mnême** was then also nominated for a **1998 Sounds Australian National Award**, for the Best Composition by an Australian Composer performed during 1997.)

PERFORMANCE NOTES

1. GENERAL REMARKS

I wish to thank *Winsome Evans* and each member of *The Renaissance Players* – they are all listed after my Programme Annotation – for their technical advice regarding early-music instruments ... not to mention their constant support during the composition and rehearsal of **[p]s(t)ellor/mnême**. I do appreciate their affable generosity. Andrew Stiller's wonderful **Handbook of Instrumentation** (University of California Press, Berkeley, California, U.S.A., 1985) also proved invaluable.

INSTRUMENTATIONAL REQUIREMENTS

- **Soprano Recorder** ('soloist')
- **Finger Cymbals** (1 pair)
- **Small Clash Cymbals** (1 pair, hand-held)
- **16 Handbells** (2 players)
{the bells are suspended in a framework and struck by pairs of mallets}
- **1 Mandola**
- **1 Celtic Harp**
- **1 Alto Rebec**
- **1 Waterphone** (played by the rebecist only during the final section of the work)
- **3 Bass Viola da Gambas**

Note: descriptions of all of these instruments (as well as acceptable substitutions) shall be given later; I have also appended to these Performance Notes a table that shows their specific *tings* or *scordature*, and a diagram depicting the instruments' *physical layout*.

The tuning of all (well-pitched) instruments must be centred upon either A440 Hz or A415 Hz – unless semitonal string-retunings are practicable.

TEMPORAL ORGANIZATION, CONSORT COORDINATION, RESONANCE AND NOTE-LENGTH

Aside from the soloist's part, the score of **[p]s(t)ellor/mnême** is notated entirely in *time-space notation*, with each 'ictus' (short, thick vertical stroke) corresponding to *one second* of elapsed time, according to the formula *40 millimetres ≈ 1 second = metronome 60*.* Therefore, musical events in this piece should be deployed chronometrically in direct proportion to their relative horizontal placement upon the score-page: an electronic metronome flashing once per second might prove to be an effective practice tool in this respect. Yet I strongly discourage any sense of metricated rigidity! (Indeed, temporal *asymmetry* ought to be strived for.)

Nevertheless, in order to facilitate ensemble coordination, the broken consort in **[p]s(t)ellor/mnême** definitely requires a *timekeeper* – somebody, seated behind the soloist, who simply 'beats' each ictus and paces inter-sectional pauses. (The timekeeper is *not* a conductor in any conventional sense: their rôle is by no means interpretative.) If there is a shortage of personnel, a not entirely desirable solution would be to have the finger-cymbalist sit behind the soloist to fulfil the rôle of timekeeper as well!

At the microformal level, 'rhythmic' notation for the string instruments in **[p]s(t)ellor/mnême** has been radically economized, consisting merely of painstakingly deployed noteheads (all but a few of them without any 'extenders'): whenever plucked, strings must be allowed to vibrate to extinction – wherever possible – and are *never* to be

damped; whenever bowed, notes are to be sustained either fully (i.e. right up to the next sonority) or as much as is practicable given local technical exigencies – with inevitable caesurae being as brief as possible (lasting at most 1 second under any circumstance). When there is no 'next sonority' within my framework of temporal proportionality – as is the case for the last notes of each section – the end-point of an *extender* will indicate the termination-moment of a (previously sustained) note.

* The three viola da gamba parts in section 5 and section 6 are all, I must confess, *extremely difficult* to execute in time when the formula 40 millimetres ≈ 1 second is operative. So – although it does undermine my compositional intentions (being contrary to my chronomorphological conception of this piece) – *if it proves absolutely necessary*, the 'time-space tempo' may be slowed down, to a minimum of 40 millimetres ≈ 2 seconds *throughout the whole work*. Sectional proportionalities must be preserved at all costs!

THE OPTIONAL PAUSES BETWEEN SECTIONS

Optional pauses between certain sections of **[p]s(t)ellor/mnême** – denoted by *peaked fermatas* (^) – have been proposed, to assist in the coordination of sectional beginnings. Since they all lie *between* sections, the consort must not 'play through' them; it will also prove necessary to agree in rehearsal upon which of these pauses shall occur during live performance. Precise durational details of such optional pauses are left to the discretion of the timekeeper – although they all ought to be varied in length, lasting somewhere between 0.5 and 3 seconds.

DYNAMIC INDICATIONS

Apart from the traditional dynamic markings (*ppp*, *pp*, *p*, *mp*, *mf*, *f*, *ff*, *fff*) – all of which I have envisaged as representing (absolute) perceived loudnesses rather than (relative) performative actions – the following symbols are employed in **[p]s(t)ellor/mnême**:

○ represents the final vanishing into *inaudibility*: allow the sound to attenuate to *silence*;

f poss. is an abbreviation for performers to play 'as loudly as possible'.

PITCH DESIGNATION AND MICROTONES

In any references to pitch in **[p]s(t)ellor/mnême**:

"Middle C" shall be designated as C_‡3, the C_‡ one octave higher as C_‡4, etc. (i.e. assuming that A_‡3 = 440 Hz, then C_‡3 ≈ 261.6255653 Hz).

‡ and † denote a *quartertone above* ‡, and a *quartertone below* ‡, respectively. (These quartertones are *well-tempered*, being the generative interval of 24-tone equal temperament.) Smaller degrees of intonational deviation – slight microtonal inflections, non-tempered, of up to an eighthtone – upwards and downwards are indicated by upward-pointing and downward-pointing arrowheads, respectively, upon accidental symbols. Examples: B_‡5; F_‡4; A_‡3; G_‡2 etc.

RANDOMIZED PARAMETERS

Within most of the instrumental parts which comprise **[p]s(t)ellor/mnême**, a number of technical/musical parameters have been bracketed thus: *Rand* { }. Until countermanded by some other randomization directive, all of these bracketed parameters may be

RANDOMIZED PARAMETERS

Randomize: {alternations between clashes of parallel cymbal-plates (i.e. like hi-hat cymbals being held vertically) and where one instead suspends the finger cymbals horizontally and taps them together, edge-to-edge; $ppp \leftrightarrow (m)p$ (dynamic levels ranging between ppp and $(m)p$)}

SMALL CLASH CYMBALS

The pair of *small clash cymbals* required for **[p]s(t)ellor/mnême** are the traditional hand-held clash cymbals, of thin gauge, between 350 mm and 400 mm in diameter – the sort of clash cymbals employed for ‘authentic’ performances of early music.

RANDOMIZED PARAMETERS

Randomize: {*strisciato* (i.e. an effect produced by starting with the cymbal-plates in contact with each other and then sliding them apart rapidly to produce a delicate ‘zing’); single point of attack along the edge (e.g. one suspends the clash cymbals horizontally and taps them together, edge-to-edge); $ppp \leftrightarrow (m)p$ (dynamic levels ranging between ppp and $(m)p$)}

16 HANDBELLS

The 16 *handbells* required for **[p]s(t)ellor/mnême** are all suspended in a framework and struck by pairs of mallets; 2 (or more) campanists will be needed, each controlling (up to) 8 bells. (The handbells’ pitches have been appended to these Performance Notes.)

These 16 handbells – each with its own internal felt ‘clapper’ and a leather hand-strap – all came from a somewhat larger series, comprising the pitches:

G♯2, A♯2, B♯2, thence chromatically – from C♯3 to C♯6, inclusive.

There are no truly satisfactory substitutes for handbells – although, as a last resort, the lowest ones (which might be quite difficult to acquire) could be supplanted by appropriately tuned *gongs* or even by large, suitably pitched *Japanese temple bells* (*rin*).

THE 11 HANDBELL-PEALS

The initial attack of each handbell-peal must be precisely synchronized by both campanists, after which their remaining ten attacks ought to be “uncoordinated and irregular – at your own pace”. It would also be musically advantageous if the campanists were to *vary the duration of every handbell-peal*: in my score of **[p]s(t)ellor/mnême**, such peal-durations have been signified on purpose somewhat ambiguously by *large oblong fermatas* (—); each handbell-peal’s pacing and time-span might even be made to correlate approximately with the length and density of the section it introduces! Beyond the final attack of every handbell-peal, a momentary hiatus of ‘suspended time’ – through which the handbell-sounds resonate beautifully – shall be permitted to assert itself: notated using *peaked fermatas* (^), these, too, should be temporally variegated; they also fulfil a practical function – to allow the timekeeper to coordinate the consort’s time-count thereafter.

HANDBELL MALLETS

The following pictographs illustrate the two basic types of handbell mallets called for throughout **[p]s(t)ellor/mnême**:



denotes a hard felt-wound mallet. {*Handbells 1* – playing the eight highest bells}



denotes a felt-wound mallet of medium hardness. {*Handbells 2* – playing the eight lowest bells}

Such pictographs are vague guidelines only! Both campanists are wholeheartedly encouraged to experiment by changing mallet-types from one peal to another – for the sake of timbral and dynamic variety. The handbells’ sounds, though, should *never*, under any circumstances, be too clangorous: their pitches must always be clearly discernible, possessing a rich and yet at times fairly mellow timbre (wherein the handbells’ lower partials are suppressed or attenuated as little as possible) ... even when the highest bells have been hit hard!

WATERPHONE

The *waterphone* – played by the rebecist only during the final section of **[p]s(t)ellor/mnême** – is a very rare and unusual instrument that hails from California: invented during the 1970s by Richard Waters, it is a strange-looking yet absolutely exquisite sound-source, having a bulbous metal body, a small elongated cylindrical funnel through which water is poured, and a series of metal prongs of different lengths welded around the outer edge of its base. The waterphone is held by the end of its funnel, and may be continuously tilted through various angles to induce the water to slurp around inside. Whenever its prongs are bowed, flicked, scraped, stroked, plucked or otherwise activated, an eerie, ethereal, kaleidoscopic sound (somewhat reminiscent of whale-song?) is forthcoming. Because a waterphone is so visually conspicuous, for the sake of surprise during a live performance it should be well hidden from the audience’s gaze by being placed within a sufficiently large box – only to be brought out at the very end of section 10, just prior to being played.

Procuring a waterphone may well be quite problematic; less *recherché* substitute-instruments are likely to be needed. I have found that one or – better still – two *flexatones*, bowed and subjected to random pitch-changes while being allowed to resonate freely, mimics the timbral signature of a waterphone surprisingly well! An even more delicious possibility (involving not just the rebecist, but some additional instrumentalists chosen from among those who would not otherwise play throughout **[p]s(t)ellor/mnême**’s eleventh section): with the flexatone(s) being most prominent acoustically (situated towards the front, nearest the soloist), the consort could easily congregate a diverse corpus of appropriately-sounding metallic percussion instruments – *musical saws* (primarily bowed, yet also struck occasionally with vibraphone mallets of medium hardness), bowed *cymbals* (Turkish- and/or Chinese-style), a one-octave chromatic set of bowed *crotales* (bowed and/or struck [with hard glockenspiel mallets]), *metal-tube windchimes* of various sizes and tessituras, a *Mark tree*, *sleighbells*, *sistrums*, *strings of jingle bells* (comprising small pellet-bells, tiny bronze bells, or miniature iron herd-bells), a *Chinese bell tree*, *windchimes of triangles*, etc.

4. THE STRING INSTRUMENTS: DETAILS

PRELIMINARY OBSERVATIONS

Throughout my score of **[p]s(t)ellor/mnême**, all string parts (except for that of the *Celtic harp*) are essentially *transposing* – in accordance with those tunings or *scordature*

tabulated after these Performance Notes. I have therefore adopted a *tablature* approach herein: my string notation does not necessarily show the resultant pitches heard, but rather those ‘notes’ to be fingered.

THE SPECIFICATION OF STRINGS AND COURSES

Within the *alto rebec* and three *bass viola da gamba* parts from [p]s(t)ellor/mnême, particular strings are specified by *Roman numerals* (as is usual for bowed string instruments), with the Roman numeral I representing the highest-pitched string. In the case of the *mandola*, however, the course to be played upon at any given moment is indicated thus: G, D, A, E (each letter being circled within my score). Whenever any such symbols have been omitted, the musical context surely renders the choice of string/course obvious; in these situations, there will probably be just a single possibility anyway...

ARPEGGIATION

↓ • – rapidly arpeggiate the notes of the chord; speed of execution is left to the discretion of the player.

Arrowheads indicate the *direction* of the arpeggio’s action: ↑ = play the *lowest pitch* of the chord first; ↓ = play the *highest pitch* of the chord first.

NATURAL HARMONICS

↙ – on the specified open string(s) or course(s), lightly touch the *node* (with a left-hand finger) at or near that fret/location corresponding to the pitch notated with a broken-diamond notehead, while bowing or plucking ... in order to produce the natural harmonic sound. Harmonics must always be allowed to ring on.

I encourage the string players themselves to find a *bowing or plucking position* that furnishes the *cleanest, most sonorous timbral quality* for each harmonic. (Occasionally, however, technical or physical constraints may restrict the ambit of choice for a harmonic’s bowing or plucking position.) Note: Resultant pitches of natural harmonics are nowhere displayed within the score itself.

The *viola da gambas’* broken-diamond noteheads are always preceded by ♮ (never by any other accidentals).

MANDOLA

The name *mandola* is apparently somewhat ambiguous; it can refer to several distinct, hybrid instruments from – or cognate to – the *mandolin family* (including one that is tuned just like a *viola*, and the so-called *Irish bouzouki*). However, the instrument I have in mind for [p]s(t)ellor/mnême is synonymous with the *octave mandolin* – namely, a large mandolin whose strings, when tuned normally, sound *one octave lower* than those of the mandolin.


MICROTUNING OF THE MANDOLA’S OPEN STRINGS

One string from each course of the mandola ought to be very slightly lowered in pitch, thereby producing a richer basic timbre – a ‘chorus effect’. The resultant beat-frequencies should be no greater than 6 Hz (beats-per-second) on the open strings, with different beat-frequencies being generated upon each (open) course; precise details are left to the discretion of the mandolist.

PLECTRA

For louder dynamic levels and improved sound-projection on the mandola, I recommend the use of a thicker, less flexible plectrum – such as a “Fender Heavy”. Indeed, to obtain the widest possible dynamic and timbral range throughout [p]s(t)ellor/mnême, having the mandolist draw upon a menu of two or more different plectra would be ideal.

STRUMMING THE MANDOLA’S STRINGS BEHIND THE NUT OR BEHIND THE BRIDGE

 – strum the mandola’s strings *behind the nut*, and strum the mandola’s strings *behind the bridge*, respectively. In both cases, *all* eight strings are to be strummed, and they should always be permitted to ring on unimpeded. Note, moreover, that the direction of arpeggiation is always indicated in conjunction with these two symbols.

RANDOMIZED PARAMETERS

Randomize: {the addition of unspecified material; *hammer/pull-off* (i.e. pluck only the first note and *hammer* or *pull-off* the subsequent notes with the left-hand fingers, according to the melodic contour), *legato* (i.e. pluck only the first note, but for the subsequent notes, merely *place* or *lift* left-hand fingers on or off the fingerboard, according to the melodic contour); alternations between plucking materials (i.e. *plectra*, and the *pad* or *tip* of a right-hand finger); plucking position, from *molto sul ponticello* (i.e. plucking the string(s) *very close* to the bridge indeed) through to *molto sul tasto* (i.e. plucking *precisely* at the middle of the vibrating length of the string(s) – directly above the twelfth fret for the open string(s), or directly above the fret which is twelve frets higher than that fret where the finger stops the string [which may actually be beyond the end of the fingerboard]); *pp↔mf* (dynamic levels ranging between *pp* and *mf*), but occasionally (*f*)}

Optional: also Randomize: {*pitch-bending* and *vibrato* (i.e. the mandolist can either depress and release the string(s) *behind the bridge* with the right-hand index finger [and/or other right-hand fingers] causing the pitch to fluctuate above the written note, or they can instead push and release the string(s) *laterally* – i.e. parallel to the frets – with the left-hand finger(s), causing the pitch to fluctuate *slightly* above the written note) – both less than 10% of the time}

CELTIC HARP

Unlike our modern harp (with its pedal-operated mechanism that retunes pitch-classes globally), the *Celtic harp* instead possesses many *levers* which retune its strings *individually*: when a lever is engaged, its corresponding string’s pitch will be raised by a semitone. (Despite the Celtic harp’s smaller pitch-range by comparison with the modern harp, the former’s system of autonomous levers proffers the potentiality for composers to devise *multi-octave scale-patterns* – as I have done within [p]s(t)ellor/mnême.)

With its levers deactivated, the Celtic harp’s strings – upon the particular instrument which was employed for the world première of [p]s(t)ellor/mnême – sound thus:

D ♮ 1; thence diatonically – from G ♮ 1 to G ♮ 5, inclusive. *

* The lowest (D ♮ 1) string *has no lever*, but can be variably tuned ‘by hand’ from about C ♮ 1 up to around F ♮ 1. Note too that for [p]s(t)ellor/mnême, the E ♮ 4 string must also be tuned down ‘by hand’ a quartertone, to E ♭ 4, before its lever is applied.

HARP GLISSANDI

Execute *glissandi* on the Celtic harp by sweeping finger-pads or -nails across its strings, (roughly) according to the given contours. (Throughout **[p]s(t)ellor/mnême**, the first and last notes of all Celtic harp *glissandi* ought not to be overly emphasized!)

RANDOMIZED PARAMETERS

Randomize: {the addition of unspecified material; *glissandi* – less than 10% of the time; *près de la table* (i.e. plucking the string(s) near the Celtic harp's soundboard); *arpeggiation* (which may be interpreted quite radically, with chords being 'broken up' unevenly across a time-span of several seconds); *pp*↔*mf* (dynamic levels ranging between *pp* and *mf*), and occasionally louder – if possible}

ALTO REBEC

Because the three-string *alto rebec* is normally not supported under the chin, position-changes may be rather awkward and perhaps time-consuming. Hence, throughout **[p]s(t)ellor/mnême**, I have restricted most of the alto rebec's pitches to those which are playable in 1st position. (The few exceptions, all of them playable in 2nd position, have been well flagged within my score.) Given this constraint, certain higher pitches (as well as those sounding below open-string II's pitch) can only be produced on one string – circumventing the need for me to specify their strings explicitly with Roman numerals.

RANDOMIZED PARAMETERS

Randomize: {the addition of unspecified material; bowing position, from (*molto*) *sul ponticello* (i.e. bowing the string(s) [very] close to the bridge) through to (*molto*) *sul tasto* (i.e. bowing the string(s) 'up the neck' somewhat [on or towards the fingerboard], nearer to the middle of the vibrating string-length than usual); *vibrato* – less than 20% of the time; changes of bowing direction (*upbow* ↔ *downbow*); bowed *tremolo*; *spiccato tremolo* (i.e. throwing the rebec bow onto the string(s) – *jeté* – and then allowing it to bounce freely, perhaps with some assistance from the right hand) – less than 10% of the time; *col legno battuto* (i.e. turning the rebec bow upside down so that its wooden part alone is bounced on the string(s), to produce a distinctive woody 'click' with each attack) – less than 10% of the time; *overbowing* (i.e. using excessive bow-pressure to produce a rather harsh grating or squawking sound) – less than 10% of the time; *snap pizzicato* (i.e. ♪ : lifting the string(s) with the thumb and forefinger then allowing it to snap back percussively against the rebec's fingerboard) – less than 10% of the time; *portamenti* (*not glissandi*); *ppp*↔*mf* (dynamic levels ranging between *ppp* and *mf*), but occasionally *f*}

BASS VIOLA DA GAMBAS

Although *bass viola da gambas* are not at all uncommon instruments nowadays, any one of them in **[p]s(t)ellor/mnême** may gainfully be replaced by a much rarer bowed string instrument (if it is available!) – the *baryton*. (A *baryton* is essentially a bass viola da gamba possessing nine or so additional wire strings which are not activated directly, but instead vibrate sympathetically in response to vibrations from the instrument's six main strings: *baryton* players are therefore encouraged to experiment with the sympathetic strings' tunings – to discover [microtonal] intonations for them that furnish maximal sympathetic resonance; an extra 'randomized parameter' might also be considered for any *barytons* – the judicious, tasteful and intermittent intermingling of plucked or arpeggiated sympathetic-string tones with more orthodox sounds from the *baryton*'s main strings.)

LEFT-HAND STOPPING TECHNIQUE, AND PIZZICATI

Should certain wide left-hand stretches (particularly in double stops) from **[p]s(t)ellor/mnême** prove too uncomfortable for those viola da gamba players with small hands, then 'thumb position' violoncello technique might be adopted – although this was seldom, if ever, done historically.

Left-hand pizzicati may prove expeditious within those passages from **[p]s(t)ellor/mnême** where *pizzicati* executed ordinarily by the right hand seem too cumbersome – particularly for section 3, wherein *pizzicati* and *arco* are interlocked. However, since the left-hand-pizzicato sound is (at least to my ear) weak and timbrally 'inferior', it should only be used *if absolutely necessary* – as a last resort.

RANDOMIZED PARAMETERS

Randomize: {the addition of unspecified material; bowing position, from (*molto*) *sul ponticello* (i.e. bowing the string(s) [very] close to the bridge) through to (*molto*) *sul tasto* (i.e. bowing the string(s) 'up the neck' somewhat [on or towards the fingerboard], nearer to the middle of the vibrating string-length than usual); *vibrato* – less than 20% of the time; changes of bowing direction (*upbow* ↔ *downbow*); *ppp*↔*mf* (dynamic levels ranging between *ppp* and *mf*), but occasionally *f*}

© Ian Shanahan, Sydney, Australia; 31 July 2001.



LPJStt/ellor/mneme

TABLE OF TUNINGS AND SCORDATURE

Syms F

H. Bells

Mandola

C. Harp

A. Rebec

B.V.d.G.

B.V.d.G.

THE NOTATION OF MICROTONES

Quartertunes are well-tempered (24 e.t.):

Arrows on accidentals indicate non-tempered intonational inflections up to an eighth-tone:

PHYSICAL LAYOUT OF
THE INSTRUMENTS...

↑
AUDIENCE

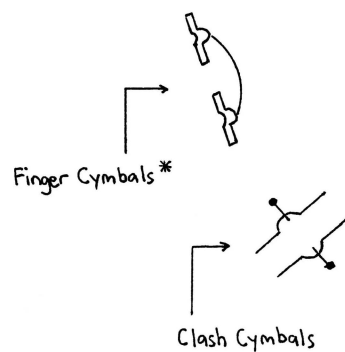
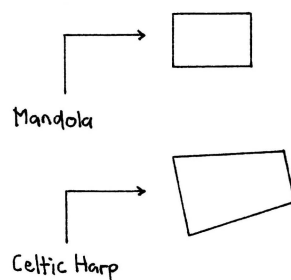
[p]s(t)ellor/mnême

© Ian Shanahan, Sydney, Australia,
23 August 1997.

• In Memoriam James Owen Shanahan
(25/9/1922 - 8/7/1997)

• To Winsome Evans;

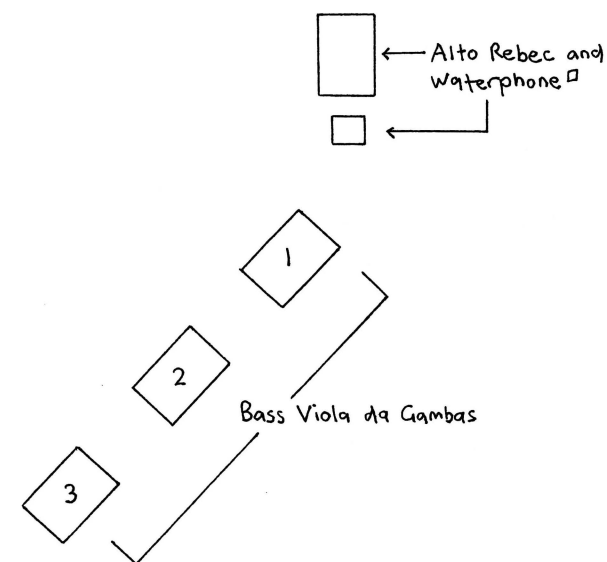
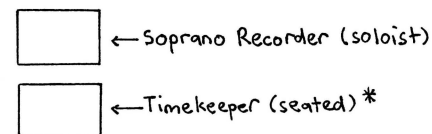
For The Renaissance Players' 30th anniversary.



Handbells - 16 bells

2



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

* A less desirable alternative: the finger-cymbalist (seated just behind the soloist) may fulfil the rôle of timekeeper as well!

□ The waterphone - sounded by the rebec player only during the final section - should be hidden from the view of the audience as much as possible by being placed in a box, prior to its playing... for the sake of surprise.

[p]s(t)ellor/mnême

α : Almost a whole breath-length; Rand {   , normal articulation, "breath trills", air-flow (such that the given pitches are elicited) }

SOPRANO RECORDER

β : Rand { octave transposition, add material, (s) pacing of events, SILENCE, articulation ( ,  ,  , normal, etc.), microtonal deviations, glissandi, vibrati, air-flow, multiphonics, +/- voice, air-noise }

37.58" (tutti): scalar, mechanical, aloof...

1 8 H. Bells 15"-20" $\langle \alpha \rangle$ $\langle \beta \rangle$

2 43.97" (solo recorder) $\langle \alpha \rangle$ $\langle \beta \rangle$

S. Rec.

3 24.07" (rebec, viola da gambas [harmonics, pizzicato]) $\langle \alpha \rangle$ $\langle \beta \rangle$

4 32.47" (harp) $\langle \alpha \rangle$ $\langle \beta \rangle$

S. Rec.

5 15.47" (mandola, rebec, viola da gambas [pizzicato]) $\langle \alpha \rangle$ $\langle \beta \rangle$

S. Rec.

6 12.52" (tutti) $\langle \alpha \rangle$ $\langle \beta \rangle$

7 26.33" (mandola, harp) $\langle \alpha \rangle$ $\langle \beta \rangle$

S. Rec.

S. REC. 1.

8 18-60" (mandola, harp, rebec)

<α>

<β>

S. Rec. 8

9 17-20" (solo recorder)

<α>

<β>

10 50-40" (tutti): infinitely calm and static...

<α>

<β> funereal...

End Rand β

S. Rec. 8

11 α: fit all sonorities into the allotted time (c.33"); include a few brief silences.
32-67" (viola da gambas [harmonics], waterphone)

<α>...

S. Rec. 8

Cymbals cue
cut-off.

Do not move!

Relax several seconds after all
instruments are silent.

FINE.

J. L. Shann
Sydney, AUSTRALIA. 9 July, 1997.

1

Inexorable (like an orrery), hieratic, luminous: beautiful and cosmic, yet with a distant strangeness...

F: Rand { } ↔ { } } C: Rand { strisciato; single point of attack along the edge }

Cym

F, C: [mf] F, C: always allow the cymbals to ring on...

2

3

4

5

6

7

= one second exactly.

F, C: Rand { ppp ↔ (m)p }

H. Bells

1, 2: uncoordinated and irregular - at your own pace.

1, 2: always allow the handbells to ring on...

Mandola, C. Harp, A. Rebec, B.V.d.G. 1-3 in \square : mechanical and gloof, almost like a wind-up toy!
 A. Rebec, B.V.d.G. 1-3: accentuate strongly the attack of each note in \square , then decrease the dynamic level immediately as the note is sustained (e.g. sfz: p).

Mandola

Rand { add notes...; hammer/pull-off, legato; plectrum ↔ finger; molto s.p. ↔ molto s.t.; pp ↔ mf (occasionally (f)f) } Optional Rand { bend string(s) - < 10%; vibrato - < 10% }

Never damp the strings!
 [f poss.]

2

3

4

5

6

7

Rand { add notes...; glissandi - < 10%; près de la table; arpeggiation; pp ↔ mf (occasionally louder - if possible) }

[f poss., non arp.] Never damp the strings!

C. Harp

2

3

4

5

6

7

Rand { add notes...; (molto) sul pont. ↔ (molto) sul tasto; vibrato - < 20%; V ↔ \square ; [spiccato tremolo] - < 10%; col legno battuto - < 10%; ∇ [overbowing] - < 10%; [snapped pizz.] - < 10%; portamento (not I glissando); ppp ↔ mf (occasionally f) }

[f, non dim...]

2

3

4

5

6

7

B.V.d.G. 1-3: Rand { add notes...; (molto) sul pont. ↔ (molto) sul tasto; vibrato - < 20%; V ↔ \square ; ppp ↔ mf (occasionally f) }

B.V.d.G.

[f poss., non dim...] mellifluous; subtle - with great purity, delicacy and gentleness throughout...

2

3

4

5

6

7

I [sul pont.]

B.V.d.G.

[f, non dim...] mellifluous; subtle - with great purity, delicacy and gentleness throughout...

2

3

4

5

6

7

VI

[f poss., non dim...] mellifluous; subtle - with great purity, delicacy and gentleness throughout...

1.

Handwritten musical score for a string quartet and mandola/cymbals. The score is divided into measures 7 through 16. The instruments are:

- Cym. (Cymbals)
- Mandola
- C. Harp (Celeste Harp)
- A. Rebec (Alto Rebec)
- 1. B.V.d.G. (First Violin da Gamba)
- 2. B.V.d.G. (Second Violin da Gamba)
- 3. B.V.d.G. (Third Violin da Gamba)

The notation includes various musical symbols such as notes, rests, accidentals, and fingerings. Measure numbers 7 through 16 are indicated above the staves. The score is written in a system with multiple staves for each instrument.

16 17 18 19 20 21 22 23 24 25

Cymys F
C

Mandola

C. Harp

A. Rebec

1

B.V.d.G.

2

B.V.d.G.

3

The musical score is written for a 16-measure piece. The top staff is for Cymys F, which is a C major scale. The Mandola part is in G major and features a series of chords and notes, with fingerings indicated by circled numbers. The C. Harp part is in G major and features a series of chords and notes. The A. Rebec part is in G major and features a series of chords and notes. The three B.V.d.G. parts are in G major and feature a series of chords and notes. The score includes various musical notations such as notes, rests, and fingerings.

Handwritten musical score for a string quartet, measures 25 to 34. The score includes parts for Cymals (Cym.), Mandola, C. Harp (C. Harp), A. Rebec (A. Rebec), and three Violins (V. 1, V. 2, V. 3).

Measures 25-34:

- Cymals (Cym.):** Measures 25-34, marked with measure numbers 25 through 34.
- Mandola:** Measures 25-34, marked with measure numbers 25 through 34. Includes fingerings (1, 2, 3, 4) and a glissando (gliss.) in measure 34.
- C. Harp:** Measures 25-34, marked with measure numbers 25 through 34. Includes a glissando (gliss.) in measure 34.
- A. Rebec:** Measures 25-34, marked with measure numbers 25 through 34. Includes fingerings (I, II, III, IV, V, VI) and a 2nd position... marking in measure 30.
- V. 1:** Measures 25-34, marked with measure numbers 25 through 34. Includes fingerings (I, II, III, IV, V, VI) and a 2nd position... marking in measure 30.
- V. 2:** Measures 25-34, marked with measure numbers 25 through 34. Includes fingerings (I, II, III, IV, V, VI) and a 2nd position... marking in measure 30.
- V. 3:** Measures 25-34, marked with measure numbers 25 through 34. Includes fingerings (I, II, III, IV, V, VI) and a 2nd position... marking in measure 30.

Handwritten musical score for five instruments: Cymals, Mandola, C. Harp, A. Rebec, and B.V.d.G. (three parts). The score is divided into measures 34 through 38. Above the staves, measure numbers 34, 35, 36, 37, and 38 are written. The Cymals part (top) has a 'C' and 'F' above the staff. The Mandola part has an '8' below the staff. The C. Harp part has a 'gliss. gentle, unobtrusive.' instruction. The A. Rebec part has a 'b' and a '#' below the staff. The B.V.d.G. parts (1, 2, 3) have Roman numerals (I, II, III, IV, V, VI) and other markings below the staff. A large diagonal line is drawn across the C. Harp staff from measure 34 to 38. In the top right corner, there is a handwritten note: 'c. 1"-2" A Optional'.

2

Handwritten musical score for measures 1 through 7. The score includes staves for Cymals, Handbells (1 and 2), Mandola, C. Harp, A. Rebec, and B.V.d.G. (1, 2, and 3).

Measure 1:

- Cymals:** F, c: [mf]
- Handbells:** 1, 2: uncoordinated and irregular - at your own pace. *fff...*
- Mandola:** 8 # [f poss.]
- C. Harp:** [f poss.] gliss. rapid, violent. *[non arp.]*

Measure 2:

- Handbells:** 1, 2: uncoordinated and irregular - at your own pace. *fff...*
- Mandola:** 8 # [f poss.]
- C. Harp:** [f poss.] gliss. rapid, violent. *[non arp.]*

Measure 3:

- Handbells:** 1, 2: uncoordinated and irregular - at your own pace. *fff...*
- Mandola:** 8 # [f poss.]
- C. Harp:** [f poss.] gliss. rapid, violent. *[non arp.]*

Measure 4:

- Handbells:** 1, 2: uncoordinated and irregular - at your own pace. *fff...*
- Mandola:** 8 # [f poss.]
- C. Harp:** [f poss.] gliss. rapid, violent. *[non arp.]*

Measure 5:

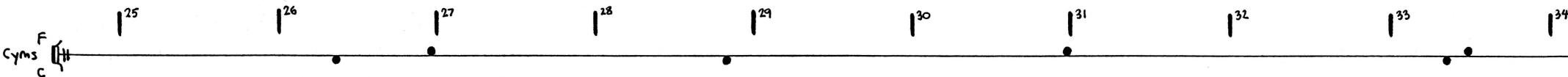
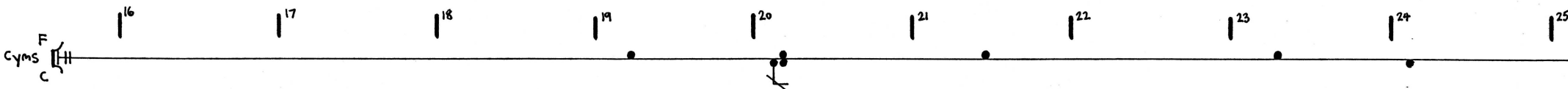
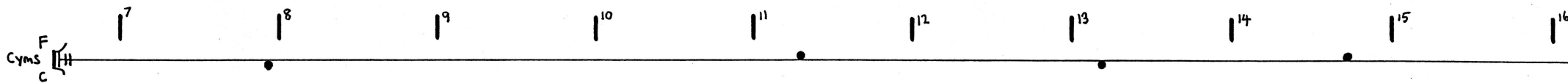
- Handbells:** 1, 2: uncoordinated and irregular - at your own pace. *fff...*
- Mandola:** 8 # [f poss.]
- C. Harp:** [f poss.] gliss. rapid, violent. *[non arp.]*

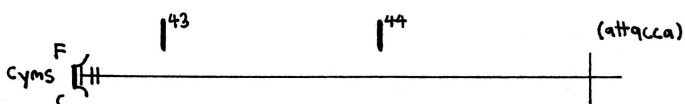
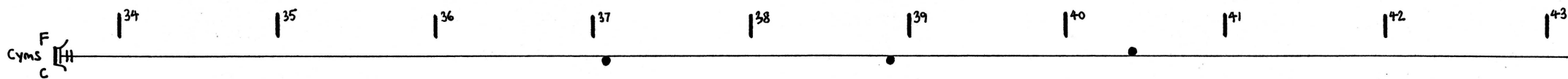
Measure 6:

- Handbells:** 1, 2: uncoordinated and irregular - at your own pace. *fff...*
- Mandola:** 8 # [f poss.]
- C. Harp:** [f poss.] gliss. rapid, violent. *[non arp.]*

Measure 7:

- Handbells:** 1, 2: uncoordinated and irregular - at your own pace. *fff...*
- Mandola:** 8 # [f poss.]
- C. Harp:** [f poss.] gliss. rapid, violent. *[non arp.]*





3

Handwritten musical score for a chamber ensemble, featuring measures 0 through 7. The score includes parts for Cymals, Handbells, Mandola, C. Harp, A. Rebec, B.V. d. G. (1st and 2nd), and B.V. d. G. (3rd).

Handbells (H.Bells): Part 1 and 2. Dynamics: *f...*. Tempo/Style: *1, 2: uncoordinated and irregular - at your own pace.*

Cymals (Cyms): Part C. Dynamics: *F, c: [mp]*.

Mandola: Part 8.

C. Harp: Part [f poss., non arp.].

A. Rebec: Part 2nd position... [non vibrato].

B.V. d. G. (1st): Part 1. Dynamics: *pizz.*, *arco*. Fingering: I, II, III, IV, V.

B.V. d. G. (2nd): Part 2. Dynamics: *pizz.*, *arco*. Fingering: I, II, III, IV, V, VI.

B.V. d. G. (3rd): Part 3. Dynamics: *pizz.*, *arco*. Fingering: I, II, III, IV, V.

Handwritten musical score for five staves, numbered 1 to 5 on the left margin. The staves are labeled as follows:

- Staff 1: Cym. (Cymbal)
- Staff 2: A. Rebec (Violin)
- Staff 3: B.V.d.G. (Bass Violoncello)
- Staff 4: B.V.d.G. (Bass Violoncello)
- Staff 5: B.V.d.G. (Bass Violoncello)

The score spans measures 16 to 25. The notation includes various musical symbols and performance instructions:

- Staff 1 (Cym.):** Features a series of vertical lines indicating cymbal strikes at measures 16, 17, 18, 19, 20, 21, 22, 23, 24, and 25.
- Staff 2 (A. Rebec):** Contains melodic lines with fingerings (III, II, I, II) and performance markings such as "2nd position...", "[non vibrato]", and "pizz." (pizzicato).
- Staff 3 (B.V.d.G.):** Includes a double bar line at measure 18. It features fingerings (VI, III, IV, V, I, II, III, IV, V, VI, I, II, III, IV, V, VI) and performance markings like "pizz.", "arco", and "pizz.".
- Staff 4 (B.V.d.G.):** Includes a double bar line at measure 18. It features fingerings (I, V, III, IV, I, II, I, II, I, II, I, II, I, II, I, II) and performance markings like "pizz.", "arco", and "pizz.".
- Staff 5 (B.V.d.G.):** Includes a double bar line at measure 18. It features fingerings (IV, V, II, VI, V, II, I, II, I, II, I, II, I, II, I, II) and performance markings like "pizz.", "arco", and "pizz.".

Handwritten musical score for measures 0 through 7. The score includes parts for Cymals, Handbells, Mandola, C. Harp, A. Rebec, B.V.d.G. (Violoncello), and B.V.d.G. (Violoncello).

Cymals: F, C: [mf]

Handbells: 1, 2: uncoordinated and irregular - at your own pace. *ff...*

Mandola: 8

C. Harp: [f poss., non arp.]

A. Rebec: [f, non dim...]

B.V.d.G. (Violoncello): [f poss., non dim...]

B.V.d.G. (Violoncello): [f, non dim...]

B.V.d.G. (Violoncello): arco [(molto) s.p.]

B.V.d.G. (Violoncello): [f, non dim...]

Handwritten musical notation for measures 7 through 16. The notation is arranged in two systems, each with a Cymbal (Cyms) staff and a C. Harp staff.

System 1 (Measures 7-16):

- Cyms:** A single line with a C-clef and a key signature of one flat (B-flat). Measures 7-16 are marked with vertical lines and measure numbers. A dot is placed on the line for measures 8, 10, 12, 14, and 15.
- C. Harp:** A grand staff (treble and bass clefs) with a key signature of one flat. Measures 7-16 are marked with vertical lines and measure numbers.
 - Measure 7: Treble clef has a B-flat note; Bass clef has a B-double-flat note.
 - Measure 8: Treble clef has a B-flat note; Bass clef has a B-double-flat note.
 - Measure 9: Treble clef has a B-flat note; Bass clef has a B-double-flat note.
 - Measure 10: Treble clef has a B-flat note; Bass clef has a B-double-flat note.
 - Measure 11: Treble clef has a B-flat note; Bass clef has a B-double-flat note.
 - Measure 12: Treble clef has a B-flat note; Bass clef has a B-double-flat note.
 - Measure 13: Treble clef has a B-flat note; Bass clef has a B-double-flat note.
 - Measure 14: Treble clef has a B-flat note; Bass clef has a B-double-flat note.
 - Measure 15: Treble clef has a B-flat note; Bass clef has a B-double-flat note.
 - Measure 16: Treble clef has a B-flat note; Bass clef has a B-double-flat note.

Glissando (gliss.) markings:

- Measure 10: A wavy line labeled "gliss." connects the B-flat note in the treble clef to the B-double-flat note in the bass clef.
- Measure 11: A wavy line labeled "gliss." connects the B-flat note in the treble clef to the B-double-flat note in the bass clef.
- Measure 12: A wavy line labeled "gliss." connects the B-flat note in the treble clef to the B-double-flat note in the bass clef.
- Measure 13: A wavy line labeled "gliss." connects the B-flat note in the treble clef to the B-double-flat note in the bass clef.
- Measure 14: A wavy line labeled "gliss." connects the B-flat note in the treble clef to the B-double-flat note in the bass clef.
- Measure 15: A wavy line labeled "gliss." connects the B-flat note in the treble clef to the B-double-flat note in the bass clef.
- Measure 16: A wavy line labeled "gliss." connects the B-flat note in the treble clef to the B-double-flat note in the bass clef.

Handwritten musical notation for measures 16 through 25. The notation is arranged in two systems, each with a Cymbal (Cyms) staff and a C. Harp staff.

System 2 (Measures 16-25):

- Cyms:** A single line with a C-clef and a key signature of one flat (B-flat). Measures 16-25 are marked with vertical lines and measure numbers. A dot is placed on the line for measures 17, 18, 20, 21, 23, 24, and 25.
- C. Harp:** A grand staff (treble and bass clefs) with a key signature of one flat. Measures 16-25 are marked with vertical lines and measure numbers.
 - Measure 16: Treble clef has a B-flat note; Bass clef has a B-double-flat note.
 - Measure 17: Treble clef has a B-flat note; Bass clef has a B-double-flat note.
 - Measure 18: Treble clef has a B-flat note; Bass clef has a B-double-flat note.
 - Measure 19: Treble clef has a B-flat note; Bass clef has a B-double-flat note.
 - Measure 20: Treble clef has a B-flat note; Bass clef has a B-double-flat note.
 - Measure 21: Treble clef has a B-flat note; Bass clef has a B-double-flat note.
 - Measure 22: Treble clef has a B-flat note; Bass clef has a B-double-flat note.
 - Measure 23: Treble clef has a B-flat note; Bass clef has a B-double-flat note.
 - Measure 24: Treble clef has a B-flat note; Bass clef has a B-double-flat note.
 - Measure 25: Treble clef has a B-flat note; Bass clef has a B-double-flat note.

Glissando (gliss.) markings:

- Measure 19: A wavy line labeled "gliss." connects the B-flat note in the treble clef to the B-double-flat note in the bass clef.
- Measure 20: A wavy line labeled "gliss." connects the B-flat note in the treble clef to the B-double-flat note in the bass clef.
- Measure 21: A wavy line labeled "gliss." connects the B-flat note in the treble clef to the B-double-flat note in the bass clef.
- Measure 22: A wavy line labeled "gliss." connects the B-flat note in the treble clef to the B-double-flat note in the bass clef.
- Measure 23: A wavy line labeled "gliss." connects the B-flat note in the treble clef to the B-double-flat note in the bass clef.
- Measure 24: A wavy line labeled "gliss." connects the B-flat note in the treble clef to the B-double-flat note in the bass clef.
- Measure 25: A wavy line labeled "gliss." connects the B-flat note in the treble clef to the B-double-flat note in the bass clef.

Handwritten musical score for Cymys and C. Harp.

Cymys (Soprano staff, F-clef):

- Measures 25-33: Single notes on the staff line.
- Measure 34: A whole note chord consisting of two notes, one on the staff line and one on the first line.

C. Harp (Piano staff, C-clef):

- Measures 25-26: Single notes on the first line.
- Measure 27: A whole note chord consisting of two notes, one on the first line and one on the first space.
- Measures 28-29: Single notes on the first line.
- Measure 30: A whole note chord consisting of two notes, one on the first line and one on the first space.
- Measure 31: A single note on the first line.
- Measure 32: A whole note chord consisting of two notes, one on the first line and one on the first space.
- Measure 33: A single note on the first line.
- Measure 34: A whole note chord consisting of two notes, one on the first line and one on the first space.

Optional (Measure 34):

- A whole note chord consisting of two notes, one on the staff line and one on the first line.

Handwritten musical score for a piece, featuring multiple staves and measures.

Staff 1 (Cym): F, C: [mp].

Staff 2 (H. Bells): f... 1, 2: uncoordinated and irregular - at your own pace.

Staff 3 (Mandola): [f].

Staff 4 (C. Harp): [f poss., non arp.].

Staff 5 (A. Rebec): (II).

Staff 6 (B.V. d. G. 1): [mf, non dim...].

Staff 7 (B.V. d. G. 2): [f poss., non dim...].

Staff 8 (B.V. d. G. 3): [mf, non dim...].

The score is divided into measures, with measure numbers 1 through 7 indicated at the top. The notation includes various musical symbols such as notes, rests, and dynamic markings.

16.

Handwritten musical score for a 7-measure piece. The score includes parts for Cymals, Handbells (H.Bells), Mandola, C. Harp, A. Rebec, and B.V.d.G. (Bass Violoncello).

Measures: 0, 1, 2, 3, 4, 5, 6, 7.

Instrument Parts:

- Cymals:** F, C: [mp].
- H.Bells:** f... 1, 2: uncoordinated and irregular - at your own pace.
- Mandola:** [f].
- C. Harp:** [f poss., non arp.].
- A. Rebec:** [f, non dim...].
- B.V.d.G.:** (Bass Violoncello).

The score is written in treble and bass clefs, with various accidentals (sharps, flats, naturals) and dynamic markings (f, mp, non dim). The notation includes notes, rests, and fingerings (e.g., 1, 2, 3, 4, 5, 6, 7).

c.1st-2nd
Optional

Handwritten musical score for five instruments: Cymals, Mandola, C. Harp, A. Rebec, and B.V.d.G. (Violoncello da Gamba). The score is divided into measures 7 through 13. The Cymals part consists of a single line with a treble clef and a key signature of one flat. The Mandola part is in G major, with a treble clef and a key signature of one sharp. The C. Harp part is in G major, with a treble clef and a key signature of one sharp. The A. Rebec part is in G major, with a treble clef and a key signature of one sharp. The B.V.d.G. part is in G major, with a treble clef and a key signature of one sharp. The score includes various musical notations such as notes, rests, and fingerings. The C. Harp part features a glissando in measures 12 and 13. The B.V.d.G. part includes a section marked '2nd position...' in measure 10.

Cymals

Mandola

C. Harp

A. Rebec

B.V.d.G.

2nd position...

gliss.

Handwritten musical score for rehearsal mark 7. The score includes staves for Symphonic Cymbals (Cym C), Handbells (H. Bells 1 & 2), Mandola, C. Harp, A. Rebec, and B.V. a.G. (Violins and Violas).

Handbells (H. Bells): 1, 2: uncoordinated and irregular - at your own pace. *ff...*

Mandola: [f poss.]

C. Harp: [f poss., non arp.]

Violins and Violas (B.V. a.G.): Staves 1, 2, and 3 are present but contain no notation.

Rehearsal Mark 7: The score is divided into measures 0 through 7. Measure 0 contains the initial notation for all instruments. Measures 1 through 7 show the progression of the music, with various notes and rests for each instrument.

Handwritten musical score for three instruments: Cymys, Mandola, and C. Harp. The score is organized into three systems, each corresponding to a measure number from 7 to 16.

Cymys: The notation consists of a single horizontal line with vertical stems and dots indicating pitch and timing for measures 7 through 16.

Mandola: The notation is on a five-line staff. It includes various musical symbols such as notes, rests, and fingerings (circled numbers 1, 2, 3, 4). Specific markings include "1" above measure 7, "2" above measure 8, "3" above measure 9, "4" above measure 10, "3" above measure 11, "2" above measure 12, "3" above measure 13, "2" above measure 14, and "1" above measure 15. A bracketed section from measure 11 to 13 is marked "[f poss. —]". A downward arrow with an "X" is placed above measure 14.

C. Harp: The notation is on a five-line staff. It includes notes and rests. The word "gliss." (glissando) is written above the staff in measure 11 and below the staff in measure 12, accompanied by wavy lines indicating the glissando effect.

Handwritten musical score for three instruments: Cymys, Mandola, and C. Harp. The score is organized into three staves, each with measures 16 through 25 marked above.

Cymys: The staff shows a single melodic line with notes corresponding to measures 16-25.

Mandola: The staff includes fingering numbers (1-4) and articulation marks (accents, slurs) for measures 16-25. A double bar line is present between measures 19 and 20.

C. Harp: The staff features a complex accompaniment with a glissando (gliss.) indicated by a wavy line between measures 19 and 20.

Handwritten musical score for three instruments: Cymals (Cym), Mandola, and C. Harp (C. Harp).

The score is organized into three staves, each with a key signature of one flat (B-flat) and a common time signature (C). The measures are numbered 25, 26, and 27, with the instruction "(attacca)" written above measure 27.

Cymals (Cym): The staff shows three measures, each with a single vertical line indicating a cymbal strike. The measures are labeled 25, 26, and 27.

Mandola: The staff shows three measures, each with a single vertical line indicating a mandola strike. The measures are labeled 25, 26, and 27.

C. Harp (C. Harp): The staff shows three measures, each with a single vertical line indicating a harp strike. The measures are labeled 25, 26, and 27.

Handwritten musical score for a symphony, page 8. The score is written for the following instruments:

- Cyms** (Cymbals): F, C: [mf]
- H. Bells** (Handbells): 1, 2: uncoordinated and irregular - at your own pace.
- Mandola**
- C. Harp** (Celeste Harp): gliss.
- A. Rebec** (Arabic Rebec)
- B.V.d.G.** (Bass Violoncello): 1, 2, 3

The score is divided into measures 0 through 7. The notation includes various musical symbols such as notes, rests, and dynamic markings. The B.V.d.G. parts include the instruction [f, non dim...].

Handwritten musical score for a 16-measure piece, featuring five staves: Cymys, Mandola, C. Harp, A. Rebec, and B.V.d.G. (Violoncello).

Cymys: Treble clef, F# key signature. Measures 7-16 show a sequence of notes: G, A, B, C, D, E, F, G, A, B, C, D, E, F, G, A.

Mandola: Treble clef, 8/8 time signature. Measures 7-16 show a sequence of notes: G, A, B, C, D, E, F, G, A, B, C, D, E, F, G, A. Includes fingerings (1-4) and slurs.

C. Harp: Treble and Bass clefs. Measures 7-16 show a sequence of notes: G, A, B, C, D, E, F, G, A, B, C, D, E, F, G, A.

A. Rebec: Treble clef. Measures 7-16 show a sequence of notes: G, A, B, C, D, E, F, G, A, B, C, D, E, F, G, A. Includes fingerings (I-III) and slurs.

B.V.d.G. (Violoncello): Treble clef. Measures 7-16 show a sequence of notes: G, A, B, C, D, E, F, G, A, B, C, D, E, F, G, A. Includes fingerings (I-III) and slurs.

Handwritten musical score for four instruments: Cymys, Mandola, C. Harp, and A. Rebec. The score is divided into measures 16 through 25.

Cymys: A single staff with a treble clef and a key signature of one flat (B-flat). It contains a series of whole notes, each marked with a measure number from 16 to 25.

Mandola: A single staff with a treble clef and a key signature of one flat (B-flat). It contains a series of whole notes, each marked with a measure number from 16 to 25. Fingering numbers (1-4) are written above the notes. A double bar line is present between measures 20 and 21.

C. Harp: A single staff with a treble clef and a key signature of one flat (B-flat). It contains a series of whole notes, each marked with a measure number from 16 to 25. Fingering numbers (1-4) are written above the notes.

A. Rebec: A single staff with a treble clef and a key signature of one flat (B-flat). It contains a series of whole notes, each marked with a measure number from 16 to 25. Fingering numbers (I-III) are written above the notes. A double bar line is present between measures 20 and 21.

c.1"-2"
A
Optional

Cyms F C

25 26 27 28 29

Mandola

25 26 27 28 29

3 4 ① ② ① ③ ② ④

8

C.Harp

25 26 27 28 29

A.Rebec

I

o]

Handwritten musical score for measures 1 through 7. The score includes staves for Cymals, Handbells (H.Bells), Mandola, C. Harp, A. Rebec, and B.V.d.G. (Violoncello da Gamba).

Cymals: Measure 1: *F, c: [mp]*. Measures 2-7: *F* (indicated by dots on the staff).

Handbells (H.Bells): Measure 1: *f...*. Measure 2: *f...*. Measure 3: *1, 2: uncoordinated and irregular - at your own pace.* (written above the staff). Measures 4-7: *f* (indicated by dots on the staff).

Mandola: Measure 1: *[f]*. Measure 2: *[f]*. Measures 3-7: *f* (indicated by dots on the staff).

C. Harp: Measure 1: *[f poss., non arp.]*. Measures 2-7: *f* (indicated by dots on the staff).

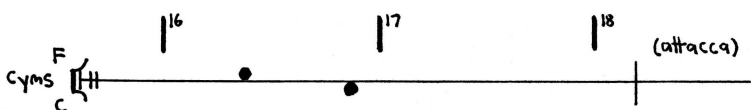
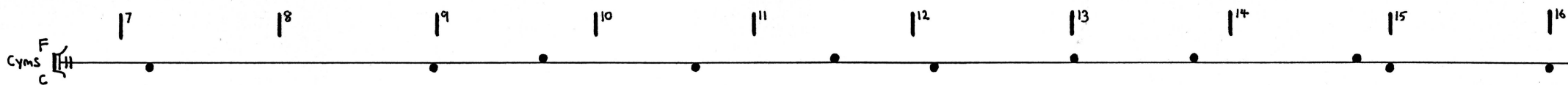
A. Rebec: Measure 1: *[(molto) s.p.]*. Measures 2-7: *f* (indicated by dots on the staff).

B.V.d.G. (Violoncello da Gamba): Measure 1: *[f, non dim...]*. Measures 2-7: *f* (indicated by dots on the staff).

B.V.d.G. (Violoncello da Gamba): Measure 1: *[f poss., non dim...]*. Measures 2-7: *f* (indicated by dots on the staff).

B.V.d.G. (Violoncello da Gamba): Measure 1: *[(molto) s.p.]*. Measures 2-7: *f* (indicated by dots on the staff).

B.V.d.G. (Violoncello da Gamba): Measure 1: *[f, non dim...]*. Measures 2-7: *f* (indicated by dots on the staff).



Score for 10 measures, featuring the following instruments and parts:

- Cyms:** F, C: [(mf)]
- H. Bells:** 1, 2: uncoordinated and irregular - at your own pace.
- Mandola:** Rand Only { plectrum ↔ finger; molto s.p. ↔ molto s.t.; pp ↔ mf }
- C. Harp:** Rand Only { près de la table; pp ↔ mf }
- A. Rebec:** Blend with the Viola da Gambas as much as possible! Rand Only { (molto) sul pont. ↔ (molto) sul tast; V ↔ Γ ; ppp ↔ mf }
- B.V.d.G. 1-3:** Rand Only { (molto) sul pont. ↔ (molto) sul tast; V ↔ Γ ; ppp ↔ mf }

The score is divided into measures 1 through 7, with a final measure (7) marked with a double bar line. The notation includes various musical symbols such as notes, rests, and dynamic markings (pp, mf, ppp).

Handwritten musical score for a 16-measure piece, featuring five staves: Cymals, Mandola, C. Harp, A. Rebec, and B.V.d.G. (Violoncello).

Staff 1: Cymals
Measures 7-16: Sustained notes on a single line.

Staff 2: Mandola
Measures 7-16: Notes with fingerings (2, 3, 4) and a sharp sign (#) in measure 15.

Staff 3: C. Harp
Measures 7-16: Notes with a glissando (gliss.) marking in measure 7 and a sharp sign (#) in measure 11.

Staff 4: A. Rebec
Measures 7-16: Notes with various fingerings (I, II, III, IV, V, VI) and a sharp sign (#) in measure 12.

Staff 5: B.V.d.G. (Violoncello)
Measures 7-16: Notes with various fingerings (I, II, III, IV, V, VI) and a sharp sign (#) in measure 12.

Handwritten musical score for five instruments: Cymals (Cym), Mandola, C. Harp, A. Rebec, and B.V.d.G. (Bass Violoncello). The score is divided into measures 16 through 25. The instruments are arranged in a system with five staves. The Cymals part is a single line with a treble clef and a key signature of one flat. The Mandola part is a single line with a treble clef and a key signature of one flat. The C. Harp part is a single line with a treble clef and a key signature of one flat. The A. Rebec part is a single line with a treble clef and a key signature of one flat. The B.V.d.G. part consists of two staves, with the first staff in treble clef and the second staff in bass clef, both with a key signature of one flat. The score includes various musical notations such as notes, rests, and fingerings. The B.V.d.G. part includes Roman numerals (I, II, III, IV, V, VI) indicating fingerings. The A. Rebec part includes Roman numerals (II, III, IV, V, VI) indicating fingerings. The Mandola part includes circled numbers (1, 2, 3) indicating fingerings. The Cymals part includes a circled number (1) indicating a fingering. The score is written in a handwritten style.

Measures: 16, 17, 18, 19, 20, 21, 22, 23, 24, 25

Instruments: Cymals (Cym), Mandola, C. Harp, A. Rebec, B.V.d.G. (Bass Violoncello)

Handwritten musical score for five instruments: Cymals (Cym), Mandola, C. Harp, A. Rebec, and B.V.d.G. (Bass Violoncello). The score is divided into measures 16 through 25. The instruments are arranged in a system with five staves. The Cymals part is a single line with a treble clef and a key signature of one flat. The Mandola part is a single line with a treble clef and a key signature of one flat. The C. Harp part is a single line with a treble clef and a key signature of one flat. The A. Rebec part is a single line with a treble clef and a key signature of one flat. The B.V.d.G. part consists of two staves, with the first staff in treble clef and the second staff in bass clef, both with a key signature of one flat. The score includes various musical notations such as notes, rests, and fingerings. The B.V.d.G. part includes Roman numerals (I, II, III, IV, V, VI) indicating fingerings. The A. Rebec part includes Roman numerals (II, III, IV, V, VI) indicating fingerings. The Mandola part includes circled numbers (1, 2, 3) indicating fingerings. The Cymals part includes a circled number (1) indicating a fingering. The score is written in a handwritten style.

Handwritten musical score for a string quartet, featuring parts for Cymals (Cym.), Mandola, C. Harp, A. Rebec, 1. B.V.d.G., 2. B.V.d.G., and 3. B.V.d.G. The score spans measures 25 to 34. The notation includes various musical symbols such as notes, rests, and fingerings, along with handwritten annotations like "2nd position..." and circled numbers (1, 2, 3, 4).

The score is organized into seven staves, each with a label on the left. The measures are numbered 25 through 34 at the top of each staff. The notation includes notes, rests, and fingerings. Handwritten annotations include "2nd position..." in measure 33 of the A. Rebec part, and circled numbers 1, 2, 3, and 4 in the Mandola part.

Handwritten musical score for five instruments: Cymals, Mandola, C. Harp, A. Rebec, and B.V.d.G. (Violoncello). The score is organized into measures numbered 34 through 43. The Cymals part consists of a single line with a treble clef and a key signature of one flat (Bb). The Mandola part consists of a single line with a treble clef and a key signature of one flat (Bb). The C. Harp part consists of a single line with a treble clef and a key signature of one flat (Bb). The A. Rebec part consists of a single line with a treble clef and a key signature of one flat (Bb). The B.V.d.G. part consists of three staves, each with a treble clef and a key signature of one flat (Bb). The notation includes various musical symbols such as notes, rests, and fingerings. The A. Rebec part includes a handwritten instruction: "End Rand; take Waterphone (and bow)".

Cymals

Mandola

C. Harp

A. Rebec

B.V.d.G.

1

2

3

End Rand; take Waterphone (and bow)

Handwritten musical score for three instruments: Cym, Mandola, and C. Harp. The score is organized into three staves, each with a vertical line of measure numbers (43 to 51) on the right. The Cym staff has a treble clef and a key signature of one flat (Bb). The Mandola staff has a treble clef and a key signature of one flat (Bb). The C. Harp staff has a treble and bass clef and a key signature of one flat (Bb). The Mandola staff includes fingerings (circled numbers) and articulation marks (accents, slurs, and a cross). The C. Harp staff includes a bass line with a key signature change to one sharp (F#) at measure 43.

Cym
 43 44 45 46 47 48 49 50 51
 Optional

Mandola
 43 44 45 46 47 48 49 50 51
 ① ③ ④ ② ③ ① ② ①
 b 8 8 8 8 8 8 8 8
 8
 End Rand

C. Harp
 43 44 45 46 47 48 49 50 51
 End Rand

35.

Handwritten musical score for three staves, numbered 1, 2, and 3. The staves are labeled on the left as Cym. F, Waterphone, and B.V.d.G. (Bass Violoncello).

Measure numbers 7 through 16 are indicated above the staves.

Staff 1 (Cym. F) shows a series of vertical lines corresponding to measures 7-16. A handwritten note "Cym. F" is written above the staff.

Staff 2 (Waterphone) shows a series of vertical lines corresponding to measures 7-16. A handwritten note "Waterphone" is written above the staff.

Staff 3 (B.V.d.G.) shows a series of vertical lines corresponding to measures 7-16. A handwritten note "B.V.d.G." is written above the staff.

Handwritten musical notation includes various notes, rests, and fingerings (I, II, III, IV, V) across the staves.

Cym $\frac{F}{C}$ | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25

Waterphone | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25

1 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25
 III — II | I II | V VI | II — I | IV — III

B.V.d.G. 2 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25
 V VI | I | V VI | II — III | I II

B.V.d.G. 3 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25
 V VI | III IV | IV V | I

are silent.

emphasize the harmonic of I,
if possible.

FINE

38.

CHAPTER 8. MEASURING PARADISE: SACRED GEOMETRY AND THE 'NEW JERUSALEM' DIAGRAM

8.1 DIMENSIONES PARADISI

8.1.1 FURTHER ANALYTICAL NOTES¹

Preliminary Remarks: on an Affinity to an Esteemed Colleague and his Work, and Dimensiones Paradisi as Cosmos

Out of respect for the composely talents of Chris Dench (whom I count as a friend) and also because **Dimensiones Paradisi** was commissioned during the early 1990s by Dench's then wife, the Australian flautist Laura Chislett, I envisage my definitive, alto-flute version of **Dimensiones Paradisi** as being a 'companion piece' to Dench's **Closing Lemma** (1986–1991), for solo flute. From his substantial *œuvre* of compositions for this medium, **Closing Lemma** is undoubtedly my personal favourite. So, as a sign of fondness for both the man and his work, the distinctive "no air! tube resonance and mechanism noise only!" gestures that recur throughout **Dimensiones Paradisi** find their root in a comparable musical fragment from **Closing Lemma** (p.1). Perhaps such passages within **Dimensiones Paradisi** should therefore best be thought of as 'evolved quotations' that rework Dench's primal material?

Another envisagement of **Dimensiones Paradisi** – one that, as luck would have it, also coincides with Chris Dench's conception of some of his own pieces – is of the work as Creation myth,² as 'cosmogonic emanation': metaphorically, I see **Dimensiones Paradisi** as a kind of sonic narrative that traverses the life of Man/Universe, from inchoate beginnings 'in time' to ultimate transcendence in a (re)union with God. And yet it is also possible that Divine *immanence* suffuses and underpins such a space – I am proclaiming here a mystical holy Spirit which 'fills Heaven and Earth'.

In deference to this hypostasis, breath (as 'spirit': *pneuma*) and breathiness – in the guise of breathy tones and random air-noises – is celebrated throughout **Dimensiones Paradisi**.³ Breathiness here is both a sign and a concretization of this metaphysical Spirit which will be reified during performance, by my composition's underlying geometric 'force-field', into a web of structured sounds.

Symbolisms and Meanings behind those Geometric Forms inhabiting the “New Jerusalem” Diagram, which undersets Dimensiones Paradisi

In Chapter 1, it was reported that the sacred mandala-like “New Jerusalem” pattern (as depicted by John Michell in his book **The Dimensions of Paradise: The Proportions and Symbolic Numbers of Ancient Cosmology**)⁴ acts both as an archetypal ground-plan for many edifices and, in particular, as an entelechial ‘force-field’ that permeates **Dimensiones Paradisi** – one which regulates this piece’s pitch-gamuts and time-spans. It is apropos for me to remind readers now that this symmetric ‘map of Paradise’ encompasses the following elemental shapes:⁵

12-gon — a dodecagon (which is not quite perfectly regular);

C₁, C₂, C₃, C₄, C₅, C₆ — six concentric circles;

S — a square;

Δ — an equilateral triangle;

HS — a ‘hexagonal star’ (or hexagram), i.e. the six-pointed Star of David;

OH — its ‘outer hex’, i.e. a regular hexagon.

A significant underlying principle behind Michell’s “New Jerusalem” pattern can be summarized as *the symbolic resolution of antitheses*, represented chiefly therein by *the quadrature of the circle* – i.e. a circle and a square interpenetrate one another and harmonize, such that they both accommodate either identical areas or commensurate perimeters.⁶ The circle itself is

[o]ne of the most common signs, often seen in relation and contrast to the square. The circle leads back into itself and is thus a symbol of unity, of the absolute and of perfection; it is thus also a symbol of heaven in contrast to earth or of the spiritual in contrast to the material; there is a close association to the symbolic significance of the wheel. As an infinite line, it is a symbol of time and infinity, often symbolized by the figure of a serpent biting its own tail. For practitioners of magic, the circle is an effective symbol of protection against evil spirits, demons, etc.; this is probably the reason for the protective function attributed to the belt, the ring, the hoop, the circular amulet, etc. In Zen Buddhism, concentric circles symbolize the highest level of enlightenment and the harmony of all spiritual powers; in other contexts, such as in Christianity, they symbolize various spiritual hierarchies or the various levels of creation. In Christianity, three intersecting circles symbolize the Trinity. The circle inscribed in a square [a geometric conjunction which is featured within the “New Jerusalem” diagram] is a common Cabalist symbol for the spark of divine fire lying hidden within matter. C. G. Jung sees the circle as a symbol of the psyche and of the self.⁷

Another prominent unifying shape within the “New Jerusalem” mandala is the hexagram (and, by extension, the hexagon – formed through the joining of consecutive vertices of the hexagram with straight lines). The hexagram is synonymous with

the “Seal of Solomon” and the “Star of David”. [It is a] six-pointed star, formed by two

triangles lying on or intertwined with one another; [the hexagram is] found particularly in Judaism, Christianity and Islam, yet is essentially the basis of the Indian *yantra* as well. In the broadest sense, the hexagram is often a symbol of the interpenetration of the visible and invisible worlds; in Hinduism, it is a symbol of the joining of *yonī* and *linga* [i.e. feminine with masculine]; in alchemy, it is also a symbol of the union of all opposites, since it is composed of the basic shapes of the signs of the elements fire Δ or air \triangle and water ∇ or earth ∇ . One can also find numerous other speculations in alchemy that assume a correspondence between the individual lines or points of the hexagram and planets, metals, and qualities. The Star of David is a symbol of faith in Judaism and is the national emblem of the state of Israel. C. G. Jung sees the hexagram as symbolizing the unification of the realms of the personal and the impersonal or also of the masculine and the feminine.^{8,6b}

Much of the iconology of the hexagram's cognate number, six, is also noteworthy:

In antiquity and during the Middle Ages, the number 6 was regarded as the most perfect number because it can be represented as the sum of its parts and as their product, i.e., $1 + 2 + 3 = 6$ and $1 \times 2 \times 3 = 6$. It can also be thought of as the product of the first masculine number and the first feminine one, i.e., $3 \times 2 = 6$. In China, 6 was associated with the influences of the sky. In Christian symbolic thought, 6 is ambivalent: as the number of the days of creation, it is holy; it is also significant as the number of works of charity; in the Book of Revelation, however, 6 appears as the number of evil; 666 is the number of the beast of the apocalypse. ...⁹

The "New Jerusalem" – in its conception as Heavenly City – is

[d]escribed in the Revelation of St. John [Chapter 21] as a city with twelve gates on a square plot of land; it is a symbol of the expected end of the world when God will dwell among His people. The city is built upon twelve cornerstones bearing the names of the Apostles; the twelve gates are twelve pearls.¹⁰

These "twelve gates" are symbolically delineated by the outermost figure of the Holy City's ground-plan, the dodecagon, which is indisputably the archetypal geometric embodiment of the number 12:

[12 is a] cosmic number yielded by multiplying the feminine 4 and the masculine 3 (there are 3 zodiacal signs in each of the 4 quarters of the zodiac!); as a product of 2 (earth) \times 2 (earth) \times 3 (fire) = 12, it is correlated with the [alchemical] element fire. In the Bible and in Christian symbolic thought, 12 plays a large role as a symbol of perfection and completeness; it is, among other things, the number of the 12 sons of Jacob and thus of the tribes of Israel, of the 12 jewels on the breast-plate of the Jewish high priest, of the 12 Apostles, and of the 12 gates of Holy Jerusalem ...; the woman in the Book of Revelation wears a crown with 12 stars; the number of the chosen is $12 \times 12,000$, a number that symbolizes the entirety of all saints.¹¹

Timbres and Instrumental Techniques as Structural Signifiers in Dimensiones Paradisi

In composing **Dimensiones Paradisi**, my desire *ab initio* was always to shun a superficial, cosmetic approach towards alto flute techniques and timbral manipulations (wherein they would be deployed quite arbitrarily, just to make a pretty cheap façade). Rather, I have continually sought to utilize them – not rigorously, but in a somewhat

ambiguous fashion – as signposts of various structural elements within this piece. This compositional attitude will not only render a rich and attractive sound-world, but definitely serves to bolster and clarify internal relationships. Such supportive correspondences in **Dimensiones Paradisi** are all typical examples of my “private cabalisms”¹² that, on the whole, match sonorically distinctive technical or timbral devices with specific patterns within the work’s causative “New Jerusalem” mandala. My original inventory of technical/structural correlations (taken straight from **Dimensiones Paradisi**’s sketch-materials) was:

exaggerated plosive attacks – macrostructural annuli (only);
 accents or *sforzandi* – microstructural annuli; otherwise free (use judiciously);
 fluttertonguing and tongue-tremoli – microstructural S (only);
 air-column vibrati – OH (only);
 key-vibrati – HS; otherwise use freely.

Let us now observe how such musical resources flag those sacred-geometric structures within section C as it unfurls:

| Figure | Grace-Notes | Beats (actual) | Timbral/Technical Treatment |
|--|-------------|----------------|------------------------------|
| C ₅ (micro–start) | 2 | 2.00 ♪ | exaggerated plosive attack T |
| C ₁ (micro–start) | 5 | ≈ 4.67 ♪ | accent (omitted!) |
| S (micro–start) | 0 | 1.80 ♪ | tongue-tremolo |
| C ₂ (micro–start) | 3 | 1.00 ♪ | accent |
| OH (micro–start) * | 0 | 2.25 ♪ | air-column vibrato |
| HS (micro–start) | 1 | 1.00 ♪ | key-vibrato |
| Δ (micro–start) | 0 | ≈ 1.57 ♪ | |
| C ₃ (micro–start) | 2 | ≈ 2.33 ♪ | accent |
| C ₄ (micro–start) | 5 | 1.00 ♪ | accent |
| C ₆ (sub- <i>omphalos</i>) | 2 | ≈ 0.00 ♪ | accent |
| to C ₄ (micro–end) | 0 | ≈ 0.29 ♪ | accent |
| to C ₃ (micro–end) | 2 | ≈ 0.67 ♪ | accent |
| to Δ (micro–end) | 5 | ≈ 1.14 ♪ | accent |
| to HS (micro–end) | 0 | 1.50 ♪ | key-vibrato |
| to OH (micro–end) | 8 | 2.25 ♪ | air-column vibrato |
| to C ₂ (micro–end) † | 6 | ≈ 2.17 ♪ | key-vibrato † |
| to S (micro–end) | 10 | 2.80 ♪ | tongue-tremolo |
| to C ₁ (micro–end) | 1 | ≈ 1.33 ♪ | accent |
| to C ₅ (micro–end) ‡ | 1 | 11.20 ♪ | |

* NB: OH (micro–start) coincides *precisely* with OH (macro–start)!

† This duration articulates HS (macro–start) after 1.00 ♪ + 5 grace-notes. The key-vibrato here therefore correlates to the macrostructural HS and *not* to C₂ (micro–end).

‡ This duration expresses Δ (macro–start) after 2.20 ♪s + 1 grace-note.

One can also discern the same kind of arcane relational strategies at play within the γ-

sections of **Dimensiones Paradisi**. Except for sections γ_2 and γ_6 , the other six γ -sections all finish with some form of iterative articulation – either fluttersong or a tongue-tremolo. Moreover, an ordered articulation-set – T, Pk, T, Tk, P (where T and P are the exaggerated plosive phonemes of ‘pizzicato’ attacks) – pervades most of the γ -sections, to function as a ‘timbral signature’ that pinpoints this section-type:

sections γ_1, γ_2 & γ_3 – T, Pk, T, Tk, P;
 section γ_4 – T, Pk, P only;
 section γ_5 – P only;
 sections γ_6 & γ_7 – none of these articulations;
 section γ_8 – T only.

Note that sections γ_4, γ_5 and γ_8 call for only some of these special articulations; nevertheless, the complete articulation-set’s fixed order is always retained.

More Instances of Proportional Self-Similarity within Dimensiones Paradisi

Within section 1.2.5, I have already shed light upon much of the network of proportionally self-similar structures that proliferate throughout **Dimensiones Paradisi**, as evocations of sacred geometry; the raw numerical data (in particular, the generative duration-constants D_1 to D_{11}) are disclosed therein. One zone of this ‘network’ in **Dimensiones Paradisi** consists of the twenty-four Greek-lettered sections (α_1 to α_8 , β_1 to β_8 , and γ_1 to γ_8), whose relative time-spans equate with these duration-constants: hence proportional self-similarity has been constituted between these ‘interjections’ and the piece’s other sections. Moreover, sections α_1 to α_8 , β_1 , and β_2 are themselves divided up in accordance with the same duration-constants, so that yet another tier of architectonic self-similarity is forged. As an illustration, I shall now explicate the proportionalities within sections β_1 and α_4 :

Dimensiones Paradisi, section β_1 (p.1)

β_1 time-span: 24.40251752" = d. This is split by D_4 into two durations $d \times D_4$ and $d \times (1 - D_4)$; the latter duration is itself then segmented by D_3 , producing three subsectional time-spans in all.

| SUBSECTIONS | DURATIONS (IN SECONDS) | CONTENTS |
|-------------|--|---|
| 1 | $3.676110977" \approx d \times (1 - D_4) \times (1 - D_3)$ | “no air! tube resonance and mechanism noise only!”, to random whistletones and air-noises |
| 2 | $12.99142072" \approx d \times D_4$ | eight multiple tremoli, whose time-spans comprise a ‘logarhythm’ |
| 3 | $7.734985822" \approx d \times (1 - D_4) \times D_3$ | C # 3, reiterated as breathy tones and key-slaps |

Dimensiones Paradisi, section α_4 (p.12)

α_4 time-span: 15.05269966" = d. This time-span d is bifurcated by D_5 into the two durations $d \times D_5$ and $d \times (1 - D_5)$; the latter duration is itself then partitioned by the duration-constant D_8 , yielding three time-spans in all (which comprise the subsections of section α_4). NB: section α_3 (pp.8–9) possesses an homologous structure, being internally proportioned according to the “New Jerusalem” duration-constants D_5 and D_9 instead.

| SUBSECTIONS | DURATIONS (IN SECONDS) | CONTENTS |
|-------------|--|---|
| 1 | $1.514341656" \approx d \times (1 - D_5) \times D_8$ | silence merging into random whistletones |
| 2 | $6.293993528" \approx d \times D_5$ | 3 multiphonics, whose durations define a ‘logarhythm’ |
| 3 | $7.244364477" \approx d \times (1 - D_5) \times (1 - D_8)$ | (a) random air-noises and whistletones, to (b) “no air! tube resonance and mechanism noise only!”, and then (c) silence; the time-spans of (a), (b) and (c) produce a second ‘logarhythm’ |

I have mentioned elsewhere that the eight sequences of alluring “pale, lunar” multiphonics in **Dimensiones Paradisi** each unfold within subsectional time-spans that correlate to the C_4 circles from the “New Jerusalem” diagram. Within such ‘ C_4 durations’, these multiphonics’ lengths have been organized so as to propagate a *third* architectonic plane of proportionalized self-similarity which is more microscopic than the rest, truly belonging to the ‘rhythmic’ level. They are also unified by the fact that the same four proportions – furnishing the same rhythmic values – are employed for all but those “pale, lunar” multiphonics within section E; only the durational order ever varies in this temporal schema. Within the tables below (which always present the “pale, lunar” multiphonic time-quantities in their correct order, as in the score), d is the number of beats partitioned self-similarly using the constants:

$$\delta_1 = D_8 \approx 0.172895589;$$

$$\delta_2 = \delta_1 \div 3 = D_7 - D_8 \approx 0.057631863;$$

$$\delta_3 = D_4 - D_7 \approx 0.301852894;$$

$$\delta_4 = D_2 - D_4 \approx 0.467619653.$$

Dimensiones Paradisi, “pale, lunar” multiphonics within section A (p.1) and section A' (p.16)

NB: C_4 (total–ideal) = $180" \div D_1 \times D_{10} \approx 5.517103542"$.

| DURATION | BEATS
(ACTUAL) | BEATS
(IDEAL) | SECONDS
(ACTUAL) | SECONDS
(IDEAL) | TEMPO (SECTIONS A & A');
DURATION-ORDER IN A' |
|---------------------|-------------------|------------------|---------------------|--------------------|--|
| ‘ C_4 ’ | ≈ 7.714 | ≈ 7.724 | 5.510204082" | 5.517103542" | $\text{♩} = 84$ |
| d | 7.000 | 7.000 | 5.000000000" | 5.000000000" | section A' : $\delta_2, \delta_1, \delta_3, \delta_4$ |
| $\delta_4 \times d$ | ≈ 6.538 | ≈ 6.547 | 2.335164835" | 2.338098265" | |
| $\delta_3 \times d$ | ≈ 4.231 | ≈ 4.226 | 1.510989011" | 1.509264470" | |
| $\delta_1 \times d$ | ≈ 2.423 | ≈ 2.421 | 0.865384615" | 0.864477945" | |
| $\delta_2 \times d$ | ≈ 0.808 | ≈ 0.807 | 0.288461538" | 0.288159315" | |

Dimensiones Paradisi, “pale, lunar” multiphonics within section B (p.5) and section B' (p.12)

| DURATION | BEATS
(ACTUAL) | BEATS
(IDEAL) | SECONDS
(ACTUAL) | SECONDS
(IDEAL) | TEMPO (SECTIONS B & B');
DURATION-ORDER IN B' |
|---------------------|-------------------|------------------|---------------------|--------------------|--|
| 'C ₄ ' | ≈ 9.857 | ≈ 9.885 | 5.501661129" | 5.517103542" | = 107.5 |
| d | 9.000 | 9.000 | 5.023255814" | 5.023255814" | section B' : $\delta_3, \delta_4, \delta_2, \delta_1$ |
| $\delta_2 \times d$ | ≈ 0.519 | ≈ 0.519 | 0.289803220" | 0.289499590" | |
| $\delta_1 \times d$ | ≈ 1.558 | ≈ 1.556 | 0.869409660" | 0.868498772" | |
| $\delta_4 \times d$ | ≈ 4.203 | ≈ 4.209 | 2.346026067" | 2.348973141" | |
| $\delta_3 \times d$ | ≈ 2.720 | ≈ 2.717 | 1.518016867" | 1.516284305" | |

Dimensiones Paradisi, “pale, lunar” multiphonics within section C (pp.6–7)

| DURATION | BEATS
(ACTUAL) | BEATS
(IDEAL) | SECONDS
(ACTUAL) | SECONDS
(IDEAL) | TEMPO (SECTIONS C & C') |
|---------------------|-------------------|------------------|---------------------|--------------------|-------------------------|
| 'C ₄ ' | 8.000 | ≈ 8.184 | 5.393258427" | 5.517103542" | = 89 |
| d | 7.000 | 7.000 | 4.719101124" | 4.719101124" | |
| $\delta_4 \times d$ | ≈ 6.538 | ≈ 6.547 | 2.203975800" | 2.206744430" | |
| $\delta_3 \times d$ | ≈ 4.231 | ≈ 4.226 | 1.426101988" | 1.424474331" | |
| $\delta_2 \times d$ | ≈ 0.808 | ≈ 0.807 | 0.272255834" | 0.271970589" | |
| $\delta_1 \times d$ | ≈ 2.423 | ≈ 2.421 | 0.816767502" | 0.815911768" | |

Dimensiones Paradisi, “pale, lunar” multiphonics within section C' (p.10)

| DURATION | BEATS
(ACTUAL) | BEATS
(IDEAL) | SECONDS
(ACTUAL) | SECONDS
(IDEAL) | TEMPO (SECTIONS C & C') |
|---------------------|-------------------|------------------|---------------------|--------------------|-------------------------|
| 'C ₄ ' | 8.000 | ≈ 8.184 | 5.393258427" | 5.517103542" | = 89 |
| d | 6.000 | 6.000 | 4.044943820" | 4.044943820" | |
| $\delta_3 \times d$ | ≈ 3.626 | ≈ 3.622 | 1.222373132" | 1.220977998" | |
| $\delta_4 \times d$ | ≈ 5.604 | ≈ 5.611 | 1.889122114" | 1.891495226" | |
| $\delta_1 \times d$ | ≈ 2.077 | ≈ 2.075 | 0.700086430" | 0.699352944" | |
| $\delta_2 \times d$ | ≈ 0.692 | ≈ 0.692 | 0.233362143" | 0.233117648" | |

Dimensiones Paradisi, “pale, lunar” multiphonics within sections E and E' (p.9)

| DURATION | BEATS
(ACTUAL) | BEATS
(IDEAL) | SECONDS
(ACTUAL) | SECONDS
(IDEAL) | TEMPO (SECTIONS E & E') |
|----------------------------------|-------------------|------------------|---------------------|--------------------|-------------------------|
| SECTION E | | | | | = 109 |
| 'C ₄ ' | 10.000 | ≈ 10.023 | 5.504587156" | 5.517103542" * | |
| d | 4.000 | 4.000 | 2.201834862" | 2.201834862" | |
| $d \times 9 \div 65$ | ≈ 1.108 | ≈ 1.108 | 0.304869442" | 0.304869442" † | |
| $d \times 6 \div 65$ | ≈ 0.738 | ≈ 0.738 | 0.203246295" | 0.203246295" † | |
| $(\delta_3 + \delta_4) \times d$ | ≈ 6.154 | ≈ 6.156 | 1.693719125" | 1.694251479" | |
| SECTION E' | | | | | = 109 |
| d | 4.000 | 4.000 | 2.201834862" | 2.201834862" | |
| $(\delta_1 + \delta_2) \times d$ | ≈ 1.846 | ≈ 1.844 | 0.508115737" | 0.507583380" ‡ | |
| $(\delta_3 + \delta_4) \times d$ | ≈ 6.154 | ≈ 6.156 | 1.693719125" | 1.694251479" | |

* NB: The combined duration of sections E and E' (i.e. 5.000 + 5.000 = 10 , at a tempo of = 109) correlates well to the area of the circle C₄.

† Because the “New Jerusalem” duration-constants were not engaged here, we see a degeneration of self-similarity within section E. (This is yet another case of symmetry-breaking in **Dimensiones Paradisi**.)

‡ The multiplier $(\delta_1 + \delta_2) = D_7 \approx 3 \div 13$.

ENDNOTES

1. Many aspects of **Dimensiones Paradisi** have already been closely analysed in Chapter 1: statistical weightings of the “pale, lunar” multiphonics – together with my definitions of ‘gamut’ and ‘subgamut’, including the latter’s statistical and virtual nature (within section 1.2.3); the (sub)gamuts’ structures, symmetry-breaking, and – crucially, as far as this chapter’s analytics are concerned – proportional self-similarities between the various architectonic layers of **Dimensiones Paradisi** (in a hefty subsection towards the end of section 1.2.5); the polysemy of this work’s poetic verbal directives (within section 1.2.6); randomness (within section 1.2.7); and – finally – **Dimensiones Paradisi**’s ‘logarithms’ (within section 1.2.11.3).
2. This perspective has already been affirmed within section 1.2.6.
3. See also section 1.2.10, where the idea of duration being governed by breath is discussed.
4. Michell (1988).
5. For information concerning the symbolisms of the square and triangular forms, consult sections 1.2.11.1 and 1.2.9 respectively.
6. Here, this geometric *rapprochement* is evinced by the circle C_1 and the square S , which both possess equal *perimeters* (and therefore identical gamut-constants Γ_3 and Γ_4).

David R. Fideler, in his Introductory Note to Michell (1991), p.72, elaborates: “The ancient Greeks were obsessed with the notion of the ‘quadrature of the circle’, or how it might be possible to geometrically construct a square and a circle of equal perimeter. Technically speaking, this is an impossible construction, owing to the irrational nature of pi. Due to this very fact, however, the problem of ‘squaring the circle’ possesses its intrinsic, symbolic appeal, for the reconciliation of the transcendental, ‘heavenly’ circle with the perfectly rational ‘terrestrial’ square represents the living fusion and reconciliation of opposites: heaven and earth, male and female, spirit and matter. Consequently, the geometry of the ‘circle squared’ has been repeatedly used in temple architecture over the ages, seeing that the temple itself represents a meeting place between heaven and earth, the eternal and temporal realms of existence. Despite the fact that the quadrature of the circle is technically impossible, there are a good many ways that the quadrature can be very accurately approximated in practice with only a compass and straight-edge. ...”

- 6b. The overlay or intermeshing of two triangles in the Star of David emblem is likewise a symbol of union, integrity, and wholeness (e.g. amalgamating masculine and feminine principles); this ‘binding of opposites’ is confirmed by Becker (1996), pp.308–309 – “For many peoples, [the triangle] is a symbol of fire and masculine virility when its tip points upward and a symbol of water and the female sex when its tip points downward” – and more expansively by Fideler (1993), pp.210–211:

| | | |
|---------------------------|------------------------------|-----------|
| KOSMOS: THE ORDERED WORLD | | |
| ▽ | [an encircled Star of David] | △ |
| water | reconciliation | fire |
| instinct | of opposites | intellect |
| luna | | sol |
| involution | KΟΣΜΟΣ | evolution |
| passive | cosmos = 600 | active |

“In the emblematic, alchemical language of traditional cosmology, the six-pointed star symbolizes the marriage of opposites through a third and higher medium, representing the creative union of the analytical intellect with the mythopoeic matrix of imagination. The upright triangle, as a symbol of the solar ego, when balanced with the inverted triangle of the lunar unconscious, produces the birth of the philosophical son: the heart and higher self. The Pythagorean philosopher Nicomachus [of Gerasa] called the hexad “The form of forms, the only number adapted to the soul . . . and the producing cause of the vital habit. Hence also, it is harmony, the perfection of parts, and more properly Venus herself.” The archetypal geometry of the hexad, as an underlying design type of both natural phenomena and the three-dimensional [orthogonal] coordinate system itself, holds a special place in the systems of traditional cosmology. It is the geometrical basis of the Pythagorean Tetraktys, the kabbalistic Tree of Life, and the “fish net” symbolism of the early Christian gnostics. As a prime archetype underlying three-dimensional space and the worlds of inner and outer phenomena, there is every reason to believe that this matrix of creation will eternally influence the fabric of nature. ...”

7. Becker (1996), p.61.

8. *ibid.*, pp.142–143.

Being a close geometric relative, the hexagon surely shares many of these symbolic meanings – particularly those associated with the number six.

9. Becker (1996), p.271.

10. *ibid.*, p.161.

Revelation 21:12–21 mentions in addition twelve angels at the twelve gates of the Heavenly Jerusalem – with the names of the twelve tribes of Israel being inscribed upon these gates; verses 19–20 name twelve types of precious stones from which the twelve foundations of the Holy City's walls are composed. Evidently, the number twelve carries considerable weight in the symbolic characterization of the "New Jerusalem". See also Michell (1988), pp.196–198.

11. Becker (1996), p.312.

12. Toop (Summer 1991), p.88.

Ian Shanahan (1991 / 1998)

– *In Memoriam Eric Dolphy* (20.6.1928 – 29.6.1964)

For Kathleen Gallagher:

~~~~~

*Dimensiones Paradisi*

for

solo alto flute

~~~~~


PROGRAMME ANNOTATION

Dimensiones Paradisi for solo alto flute

Ian Shanahan (1991/1998)

*I am the voice whose sound is manifold
and the word whose appearance is multiple.
I am the utterance of my name.*

– Thunder, Perfect Mind (Nag Hammadi Codex VI.2, 4th century AD), 14:12–15.

{Axiom: “the alto flute is a complex ecosystem, a ‘paradisaal’ cosmos unto itself ... a universe whose acoustic resources are to be ‘measured’ wisely”.}

Dimensiones Paradisi [Latin]: “measurements [dimensions] of Paradise”.

I have appropriated this rather Dante-esque sounding title from John Michell’s inspirational book **The Dimensions of Paradise: The Proportions and Symbolic Numbers of Ancient Cosmology**,* an exegetical writing on sacred geometry. It demonstrates the ancient geometrical bases – founded upon the quadrature of the circle (a symbolic melding of opposites) – which unite such diverse edifices as Stonehenge, the 12 Hides and St Mary’s Chapel of Glastonbury, Chartres Cathedral, Plato’s imaginary city of Magnesia (from **The Laws**), the Earth and Moon, and – in particular – the Celestial City (“New Jerusalem”) described by St John the Divine in **The Book of Revelation**. From their measurements, Michell evolves a complex mandala-like figure incorporating a dodecagon, several concentric circles, a hexagon, and the Star of David. This sacramental object therefore becomes the template or metaphor from which the pitch as well as the temporal data of my composition are derived, at both the macro- and micro-architectonic levels: **Dimensiones Paradisi** is, literally, that: a ‘blueprint of Paradise’ etched through vibration ... both structurally, and poetically (in terms of the nebulous, rarefied, warm, crystalline sound-world conjured up by the alto flute). Durations and lengths of sections correspond to the areas between successive shapes (moving inwards to the central point or *omphalos*), whereas the shapes’ perimeters govern pitch-gamuts (quantized to eighth tones). Thus, within each section, despite an infusion of some registrally anarchical tones, all pitches converge eventually to a single microtonal interval; these omphalic micro-intervals themselves implode towards the notional midpoint of the piece. Yet because, conceptually, the Arrow of Time ‘cuts across’ the generative symbol, there is a statistical tendency imposed upon the material of **Dimensiones Paradisi** to rise, inexorably, as if to Heaven...

Dimensiones Paradisi is dedicated to the superb Australian flautist Kathleen Gallagher: a real champion of contemporary flute music, Kathleen will deliver the work’s première performance on 26 September 1998, at the Ninth Sydney Spring International Festival of New Music. Moreover, although **Dimensiones Paradisi** originates from a different world, it is written also in memory of that intelligent musician and incomparable improviser Eric Dolphy (1928 – 1964). So – aside from feeling the greatest respect towards him – what, you may ask, is my connection with Eric Dolphy here? Answer: *deep engagement with flute physiology*. A magistral performer on alto saxophone, flute and bass clarinet, Dolphy’s creative exploration of ‘extended techniques’ was in part motivated by the researches of flautist Severino Gazzelloni. (Amongst many other things that I revere by Eric Dolphy, I remain enchanted by his album **Out to Lunch!** † – the third track, entitled **Gazzelloni**, is particularly apropos – and with Dolphy’s exquisite flute solo in the première recording of Oliver Nelson’s **Stolen Moments**.)‡

© Ian Shanahan, Sydney, Australia; 13 June 1998.

Dimensiones Paradisi, commissioned by Laura Chislett (in 1991), was premièred by Kathleen Gallagher during the Ninth Sydney Spring International Festival of New Music, Eugene Goossens Hall, ABC Centre, Harris Street, Ultimo, Sydney, on 26 September 1998.

The composer received the **Marienberg Sydney Spring Award for Composition**, for the most outstanding original Australian composition {**Dimensiones Paradisi**} performed during the Ninth Sydney Spring International Festival of New Music (1998).

* Thames and Hudson Ltd., London, 1988; ISBN 0-500-01386-1.

† Blue Note Records, CDP 0777 7 46524 2 1; recorded on 25 February 1964.

‡ Oliver Nelson’s **Stolen Moments** (1960) was originally issued on the album **The Blues and the Abstract Truth**, Impulse! Records A-5; recorded on 23 February 1961.

PERFORMANCE NOTES

PREAMBLE

I am greatly indebted to my friend *Kathleen Gallagher* for her thorough research, for her kindness in inducting me into the subtle mysteries of the alto flute, and for her patient editorial assistance later in the compositional process – particularly in relation to the deployment of alto flute fingerings in **Dimensiones Paradisi**. I offer sincere thanks as well to *Laura Chislett Jones* (who assisted me similarly with an earlier version of this piece, for piccolo), and also to *Angela Shrimpton* (whose improvisatory noodlings with the D and D# trill-keys led me to codify the flickering sonorities of sections α_1 and α_2).

STAGE PRESENTATION (WITH THE HELP OF AN ASSISTANT), AND LIGHTING

When publicly presenting **Dimensiones Paradisi**, instead of arraying its sixteen sheets of music across a forest of music-stands (whereby an ugly and impermeable barrier is erected), the use of just two music-stands together with an assistant who will *silently and unobtrusively* pull across successive pages of music is definitely recommended. Ideally, only a small stage-area encompassing the flautist (and their sheet music) should be spotlighted, with the rest of the performance space – including the page-turner, if at all feasible – remaining in total darkness, unseen.

AMPLIFICATION OF THE ALTO FLUTE

Although the alto flute should not need to be amplified in an intimate chamber music context, some sound-reinforcement will prove necessary for adequate projection in larger concert spaces. In any event, the level of amplification ought to be kept to a minimum, so that the alto flute's natural timbre will be heard as clearly as possible: discreetly implement sound-reinforcement *only when necessary*.

TEMPORAL ORGANIZATION, AND INTERPRETATION

Dimensiones Paradisi embraces 37 sections: A, B, C, D, E, F, E', D', C', B', A', G, and H; and implanted amongst these 13 lettered sections are 24 proportionally interrelated 'interjections' α_1 to α_8 , β_1 to β_8 , and γ_1 to γ_8 – all of which are bounded by special *intercut bar-lines*. The 10 sections A to E and E' to A' are disposed symmetrically about a brief central fragment or *omphalos* (section F); sections G and H can be thought of as a 'coda'. (Note also that eight of these 10 sections themselves contain a central 'sub-*omphalos*' comprising two grace-notes!) The lettered sections are demarcated by *changes of tempo* and *ordinary bar-lines*, the latter being employed exclusively for macrostructural delineation; *dotted bar-lines* circumscribe the sub-*omphaloi*, the "pale, lunar" multiphonic subsections, and the *squared-fermata* silences (\neg). Indeed, bar-lines of whatever type in themselves *never* imply any pauses, caesurae or disconnections, however ephemeral ... unless otherwise indicated.

All of the α , β , and γ sections (and section H) are notated entirely in *time-space notation*, with each 'ictus' (short, thick vertical stroke) corresponding to *one second* of elapsed time, according to the formula *40 millimetres \approx 1 second = metronome 60*. Therefore, musical events in these 25 sections should be deployed chronometrically in direct proportion to their relative horizontal placement upon the score-page: an electronic metronome flashing once per second might prove to be an effective practice tool in this

~ i ~

respect. Yet – since most durations therein are logarithmically defined – any sense of metricated rigidity is strongly discouraged! (Temporal *asymmetry* ought to be strived for.)

Aside from grace-note groups, *all* other (mensural) durations are notated spatially, in proportion, according to the abovementioned formula: *40 millimetres \approx 1 second = metronome 60*, irrespective of the prevailing metronome values! This proportionality exists purely to assist the flautist in learning the complex rhythms of **Dimensiones Paradisi**, which must be performed to a high degree of exactitude – but with *quicksilver fluidity*, not in an overtly mechanical fashion. So-called 'irrational durations' (or 'tuplets') herein may be hierarchialized into nestings of two, or even three, layers of increasingly microscopic rhythmic behaviour; they may even be independently 'fractionalized' and/or bifurcated, broken apart into incomplete sub-groupings by some intervening material. Anyway, their notations are sufficiently graphic, and self-explanatory.

Grace-note groups all lie 'outside time' – locally independent of the time-space paradigm and other metrical/durational schemata. In general, they should be played quite rapidly or even "as fast as possible", although tenuto markings and various pauses are frequently used to suggest a more leisurely or irregular approach. Indeed, nuances in horizontal spacing amongst grace-notes propound a correspondingly sophisticated rhythmic interpretation that is, notwithstanding, left to the executant to some extent. Furthermore, despite their autonomous unfurling, grace-notes ought not to be thought of as mere 'ornaments', of secondary architectonic status, to the 'main notes': in **Dimensiones Paradisi**, *all* sonorities are equally important, belonging as it were to a 'Heavenly democracy'!

"*mercurial: 'as fast as possible'!*" – thenceforth abbreviated to "*mercurial...*" (in conjunction with a grace-note group) – constitutes a 'local tempo' which will always be utterly dependent upon certain factors such as pitch-contour, dynamic levels, fingerings and other technical exigencies, the mandatory attainment of clarity (i.e. that each sonority still must be *clearly discernible*: i.e. 'as fast as *articulately* possible!'), your overall flautistic virtuosity, how well you feel at the time, room acoustics, etc. "*mercurial...*" is, therefore, 'micro-contextual' and potentially forever variable – a precise directive without a predictable outcome! So, for this mode of performance, do not necessarily strive for evenness of speed: rather, rhythmic fluidity, naturalness and – where applicable – asymmetry should be your goals. (Think of the continuity of a fast-flowing river, with its ceaselessly evolving inner turbulences, eddies, whirlpools, and its more sedate currents.)

Finally, a serious caveat: altering designated fingering-configurations simply to render any passage 'more technically facile' is absolutely discouraged! Among "*mercurial...*" grace-note groups in particular, where unevenness may well be premeditated and favourable, the local chronomorphology on the whole stems directly from the alto flute's fingering-mechanism (the Boehm system) itself!

PAUSES

Unless otherwise indicated, precise durational details of pauses are left to the interpretation of the performer. The following symbology is employed:

- ◌ is a *comma*, denoting a *slight caesura* – not necessarily for the purpose of taking a breath;
- Λ is a *peaked fermata*, denoting a *relatively brief pause* (increasing a duration by no more than a factor of 2);

~ ii ~

◻ is a *squared fermata*, denoting a *relatively lengthy pause* (increasing a duration by at least a factor of 2.5). Whenever this symbol appears within the stave, in bold, the duration of the pause is always specified above the stave (in seconds).

BREATHING

✓ denotes a *breathing space*. Inhalation should be carried out wherever indicated as furtively and as efficiently as possible. It is expected that such indrawing of air will intrude somewhat into the rhythmic design, so that pauses for breath are bound to arise: these should be kept as brief as possible!

Although *circular breathing* is nowhere requested in **Dimensiones Paradisi**, its employment is allowed – but only whenever it is felt to be *absolutely necessary*: for flautists with small lung-capacities who have perfected this technique, circular breathing within the longer β sections might be deemed applicable, for instance.

ADJUSTMENT OF TEMPI

Should slightly lower tempi be preferred in **Dimensiones Paradisi**, then *all* tempi – as well as the time-space ‘meta-beats’ of all 25 sections α , β , γ , and H (as defined by their periodic ictuses, drawn every 40mm \approx 1 second = metronome 60) – *must* be lowered, proportionately, by the same factor ... lest the work’s architecture be distorted. (Likewise, the duration of each pause lasting a given number of seconds will need to be multiplied accordingly.) Do be aware, moreover, that slowing down the pace beyond a certain threshold could necessitate resorting to *circular breathing* in certain passages.

DYNAMIC INDICATIONS

The following gradient of dynamics is employed throughout **Dimensiones Paradisi**:

ppppp pppp ppp pp p mp mf f ff fff ffff

In addition:

○ represents the initial emergence from, or final vanishing into, *inaudibility*;

p poss. and *f poss.* are abbreviations for ‘as soft as possible’ and ‘as loud as possible’, respectively;

within those passages denoted “pale, lunar”, most multiphonics are given a *dynamic range*, including the minimum and maximum dynamic levels: e.g. *p↔mf*.

ARTICULATION

All articulations – *legato*, *tenuto*, *mezzo-staccato*, *staccato*, *staccatissimo*, *accent* (>), *sforzando* (^) etc. – should be duly observed. For the purposes of this composition, a *tenuto* marking (–) is simply to be understood as a direction to sustain a sonority for its *full duration* (or even slightly longer): *tenuto* carries no implication of *any* additional accentuation whatsoever, unless otherwise indicated. The following special articulations are also utilized in **Dimensiones Paradisi**:

① denotes an *aspirated attack*, using the phoneme ‘h’ (as in “*h*amster”): the sonority is to be rendered *without any tonguing whatsoever*. When this articulation is

underpinned by an accent, the aspiration is intensified so that it becomes a *diaphragm thrust*.

① ② denotes an *exaggerated plosive attack*. Attack the sonority, explosively, with an over-emphasized ‘t’ (as in “*t*iger”) or ‘p’ (as in “*p*ig”), in order to create conspicuous transient noise/overblowing. Local dynamic indications provide basic guidelines as to the strength of the attack.

k denotes a *velar plosive attack*, using the phoneme ‘k’ (as in “*k*itten”).

↑ denotes ‘*pizzicato*’, using either the tongue or the lips (as indicated) – an exaggerated plosive sonority produced entirely by the articulators, without *any* pulmonary action whatsoever! A quite resonant popping sound should result.

• denotes a *tongue-ram* (unvoiced). Whilst fingering the (first-register) note designated by the circular notehead, violently drive the tongue right into the alto flute’s embouchure-hole, accompanying this forceful articulation with considerable pulmonary/diaphragmatic support. An extremely resonant reverse-envelope ‘thud’ should ensue, possessing a discernible pitch – indicated by the regular notehead – approximately a major seventh below the fingering’s normal first-register pitch.

≡ denotes *fluttersong*, a trilling of the tongue-tip against the alveolar ridge, or alternatively, a trilling of the back of the tongue against the uvula (soft palate) – as in gargling. Either type of fluttersong is acceptable within **Dimensiones Paradisi**: the type and intensity of the fluttersong to be employed at each occurrence is left to the discretion of the flautist.

✂ denotes a *tongue-tremolo*. Articulate, *as quickly and as evenly as possible*, the (double-tonguing) phonemes ‘[d]idl(d)idl(d)idl...’ – as in “*m*iddle” – or the much more common (double-tonguing) pattern ‘[t]eketeki...’ (‘[d]egedege...’). The type and intensity of the tongue-tremolo to be employed at each occurrence is left to the discretion of the flautist.

With both *fluttersong* and *tongue-tremoli*, an arrow (→) adjacent to the above symbols calls for the ‘fading in’ and/or ‘fading out’ of these iterative articulations as *smoothly as possible*, rather than merely switching suddenly from one articulatory mode to another. Note too that in the β sections (only), such articulations evolve *independently of all other performance parameters*: their autonomous transformations are portrayed upon the noteheadless stems beneath the stave, where the prevailing articulation-type is to be maintained until the next instruction overrides it.

EMBOUCHURE ADJUSTMENTS

↑ denotes a *rolling out* of the alto flute’s lip-plate (e.g. to correct some flatness of intonation).

↓ denotes a *rolling in* of the alto flute’s lip-plate (e.g. to correct some sharpness of intonation).

ALTO FLUTE FINGERINGS

Every fingering-indication provided within the score of **Dimensiones Paradisi** that *supplies the notated pitch(es) accurately over the given duration* is to be strictly adhered to: any modifications of such fingerings are forbidden! But whenever a fingering yields an unacceptably inaccurate outcome, or is acoustically untenable on a particular instrument,

then the performer is at liberty to alter that fingering – subject to the proviso that the resultant sonority matches, as closely as possible *in context*, the composer's original intention. If no such fingering exists, then just utilize the provided fingering: more accurate pitch might even be procured by rotating the lip-plate (i.e. rolling the alto flute in or out) accordingly.

Because intonational nuances and timbral heterogeneity are very much integral to the conception of **Dimensiones Paradisi**, playing this work on any of the recently developed specialist quartertone alto flutes is *expressly prohibited* whenever such a kaleidoscopic sound-world cannot be readily accessed! Verification of all alto flute fingering-resources used herein was carried out by Kathleen Gallagher on an Altus alto flute (possessing the standard Boehm mechanism).

The following symbology is employed in relation to fingering *tablature pictographs*:

- denotes a *switch* from one state to another (e.g. an open fingerhole is then closed);
- denotes an *ongoing interchange* that involves two or more fingerings (i.e. an oscillatory, cyclical, or random [abbreviation: *rand.*] trilling action);
- - - → denotes a *transition* from one state to another (i.e. a gradual key-depression or key-release).

HARMONICS

- denotes a *harmonic*. The fundamental pitch is specified by the non-mensural, broken (three-quarter) diamond notehead: utilize the standard (first-register) fingering for this pitch, which may be audible as a relatively faint 'undertone'. The pitch of the harmonic itself is notated in the usual way, as a regular notehead with a small circle above it. *All* harmonics throughout **Dimensiones Paradisi** are designated explicitly: hence, in the absence of any tablature pictograph, a note tied to a harmonic (and possessing the same [chromatic] pitch as it) is to be played with the *normal fingering* for that pitch.

QUARTERTONES AND MICROTONE SETS

Fingerings for *quartertones* (i.e. 24-tone equal temperament) and for *microtone sets* found in **Dimensiones Paradisi** are appended within a prefatory table – to aid the flautist in checking their intonational accuracy, to assist in the familiarization process, and for general practice purposes. Such quartertone/microtone fingerings render sonorities that are variously coloured; these lovely timbral variegations were very much in mind during the writing of this piece. Their melancholy, muted, or rather plaintive quality is characteristic: please do not attempt to 'fake' more normal timbres for them!

Quartertone fingerings (generally omitted from the score itself) were chosen for their ability to furnish precisely tempered intonation comprising *equally spaced intervals*; the numerous sets of smaller microtones, by contrast, are deliberately *uneven* – a quite natural consequence of the alto flute's physiology. Slight tuning disparities arising from any of these fingerings may, however, be eliminated by *rolling in* or *rolling out* the alto flute's lip-plate.

The following symbology for *quartertone accidentals* is employed:

‡ and † denote a *quartertone above* ♭, and a *quartertone below* ♭, respectively.

~ v ~

The notation of the *microtone sets* is purely relativistic: half-arrowheads, whole arrowheads, and (in the β sections only) 'blobs' upon accidentals respectively denote increasing – but non-specific – degrees of intonational deviation, of somewhat less than a quartertone, in the given direction. (The appended fingering-charts should clarify this notational protocol.)

MULTIPHONICS

All ('inharmonic') multiphonics employed in **Dimensiones Paradisi** are appended within a prefatory table. Their notation is necessarily incomplete: sidebands, such as 'difference tones', have been excluded. Nonetheless, the pitches of the highest and lowest component tones are carefully notated (correlating, wherever possible, with the intonations assigned to the microtone sets), and should therefore be fairly accurate in performance; this can be ascertained by playing through the abovementioned table. If, however, any *infinitesimal* pitch-discrepancies do occur in playing these multiphonics on your instrument, then they can be ignored!

The *steadiness* of (unstable) multiphonics – in performing, for example, many of the α passages – is not a high priority: unless otherwise indicated, a reasonable degree of 'inner fluctuation' is quite acceptable. Similarly, it is my intention that certain *slow-speaking* multiphonics might be heard only incipiently, whenever their specified durations are insufficient to fully secure and stabilize all of their constituent pitches simultaneously.

OCTAVE MULTIPHONICS / SPLIT OCTAVES

- ◻ denotes an *octave multiphonic* or a 'split octave' (characterized notationally by a small open square in place of the single harmonic's small circle). Using the normal fingering for the lowest (first-register) note of the notated octave, darken its tone by aiming the breath exactly halfway between the air-stream positions for each of the two pitches, thereby sounding both simultaneously, as part of a *rich, murky timbre* wherein the second partial is almost as strong as the fundamental. (Note that a clear distinction between 'split octave' and 'octave multiphonic' remains elusive here; this sonority belongs somewhere within that acoustical continuum between *timbre* and *harmony*, so that its most appropriate categorization will be context-dependent.)

MULTIPLE TRILLS AND TRILL FREQUENCY

Multiple trills involve the (rapid) interplay of three or more sonorities: the initial sonority is written as the 'main note'; the other sonorities are then notated in parentheses. Tablature pictographs are always provided above the stave.

The multiple trills' elements in the β sections and in section G are to be played in *cyclical order* (i.e. first element → second → third → first → second → ...) – although an infusion of some random re-ordering is by no means undesirable. On the other hand, the sequences of microtones within the multiple trills of sections α₁ and α₂ are to be played in *a truly random fashion!* (See the footnote at the bottom of p.3 within the score.)

Note that for *all* trills – normal or multiple – throughout **Dimensiones Paradisi**, the conventional triangular waveform contour suggests micro-details of each trill's frequency, which may be static or evolving.


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OVERBLOWING OF (MULTIPLE) TRILLS

In sections β_1 , β_2 , β_6 and β_7 , (multiple) trills are required to be *overblown*, in legato (unless another articulation is indicated); this overblowing should intensify and abate in direct correspondence with the lengths and shapes of the *bold triangular contours* superposed straight on top of the extended time-space beams. Such overblowing – which develops quite independently of any trill-fingering changes! – must reach the third register *at the very least*: although precise details are left to the player, maximum variety of effect ought to be strived for.

VIBRATO

If used at all, vibrato – in particular, air-column vibrato – is to be employed *very sparingly and tastefully*, with discretion. (For instance, additional air-column vibrato is probably best avoided in the α and γ sections.) The following vibrato-types, however, are called for at specific points in the music:


A  denotes an *air-column vibrato*. The sinusoidal waveform contour suggests micro-details of the air-column vibrato's frequency and amplitude (intensity), either of which may be static or evolving.

K  denotes a *key-vibrato*. Its fingering and trilling action is specified by the tablature pictograph above the stave – unless harmonics are involved. The triangular waveform contour suggests micro-details of the key-vibrato's frequency, which may be static or evolving.

All (non-harmonic) key-vibrati employed in **Dimensiones Paradisi** are appended within a prefatory table, the rationale for selecting each key-vibrato's fingering being that it achieve maximal timbral alteration with a minimal pitch-shift, wherever possible. (I have therefore made no attempt to correlate these fingerings with those of the microtone sets.)

KEY-SLAPS

× denotes a *key-slap*: forcefully depress the relevant key(s) while initiating and/or sustaining the given sonority, thereby assimilating an audible resonant 'pop' into its timbre. Whenever a tablature pictograph is provided as well, the keys to be 'slapped down' are clearly marked thereabouts with an ×; in other contexts (e.g. *harmonics*) the finger-action is already predetermined, so that further instructions are unnecessary. (With key-slapped *trills* and *key-vibrati*, the × also appears next to the triangular waveform contour.)

 illustrates another notation, used solely on p.1, for detailing a *key-slap*. While the lowest C# is fingered (as shown by the broken [three-quarter] diamond notehead), the x-notehead affixed to the stem signals by name which key is to be snapped shut. Only five keys are involved, singly, in this activity: the A key (left-hand middle finger); the G key (left-hand ring finger); the F key (right-hand index finger); the E key (right-hand middle finger), and the D key (right-hand ring finger). 'Slapping' different keys down both facilitates rapidity of execution and maximizes timbral diversity. Note moreover that whenever the C#'s notehead is a *broken three-quarter diamond*, *no air is to be blown at all*: thus, each key-slap's percussive timbre resonates alone (in which case the quasi dynamic indication × --- is deployed underneath the stave).

"NO AIR! TUBE RESONANCE AND MECHANISM NOISE ONLY!"

This opening gesture is an important cognitive/structural anchor – a kind of 'ritornello' – in **Dimensiones Paradisi**. Although the alto flute is held in its normal embouchure-position, there is to be *no air blown at all*! The sound is generated purely through *finger-activity*: whilst the right-hand keys are gradually depressed in succession (as shown by the tablature pictographs above the stave and by the *glissando* between broken-diamond noteheads), the left-hand thumb (B), C, and G# keys are trilled *randomly*, creating rattly mechanism noises and hollow, pitched resonances within the alto flute's tube. The quasi dynamic indication (○ → × → ○) under the stave signifies a subtle introduction, thence withdrawal, of deliberate forceful *key-slaps* (with the thumb and C keys). Between each occurrence of this type of passage, aim for *maximum timbral variety*: for example, the pacing of right-hand key-depression and the profile of left-hand random trill-speeds should be noticeably different upon each reappearance of this gesture.

BREATHY TONE

◇ A closed-diamond notehead (which appears both in the stave and above it) indicates *breathy execution* – where the tone-quality has been infused with *maximum breathiness* through projecting a relatively unfocussed air-stream across the embouchure-hole. First-register tones played in this way should all sound as distinctly pitched, 'open aeolian' airy tube-resonances.

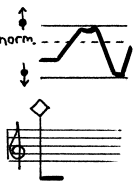
◆ A half-blackened-in closed-diamond notehead (which appears both in the stave and above it) indicates a degree of *breathiness midway between normal playing and maximum breathiness*.

◆ A fully blackened-in closed diamond (which only appears above the stave) indicates *normal timbre*, without any additional breathiness whatsoever.

A *continuous transformation from one state of breathiness to another* is depicted above the stave by an arrow (→) between closed diamonds.

Note that for *breathy tones pitched above the first register*, what is required is a somewhat diffuse to maximally breathy timbre, perhaps overlying some 'residual tones' (undertones) of various degrees of prominence. Where such breathy tones are *harmonics*, their fundamental pitches should be more conspicuous than usual, as fairly strong residual (under)tones.

RANDOM AIR-NOISE

 A large closed-diamond notehead lying above the stave indicates *random air-noise*, produced by an unfocussed air-stream blown across, or directly into, the embouchure-hole whilst carrying out random finger-movement at a random (primarily rapid) rate. Pitch-content is irrelevant here! Whenever practicable, through raising the angle of the air-stream and slightly increasing lip-tension, allow *random whistletones* to project as well. It is desirable at all times, however, to *minimize key/mechanism-noise*, unless otherwise specified.

The graphic above the diamond notehead pertains to *lip-plate angle*: its thin top line denotes a *rolling-out* of the alto flute's lip-plate *as far as possible*; its thin bottom line denotes *rolling-in* the alto flute's lip-plate so that *both lips completely enclose the embouchure-hole*; the dashed line after "norm."

denotes the normal embouchure-position. The thick black contour drawn between the two extremes signifies an *ongoing transformation of lip-plate angle*, a procedure which impacts significantly upon the air-noise pitch and timbre.

Random air-noise on the alto flute consumes a great deal of air. In order to promote timbral variety and to decrease air-consumption, the flautist may consider occasionally employing *sustained sibilant phonemes* ('s' [as in "sloth"]; 'sh' [as in "shrew"]) and *sustained fricative phonemes* ('f' [as in "ferret"]; 'th' [as in "thornbill"]). For identical reasons, and simply to replenish the lungs, the flautist may also at times *noisily inhale through the alto flute's tube*, when the lip-plate is rolled all the way in.

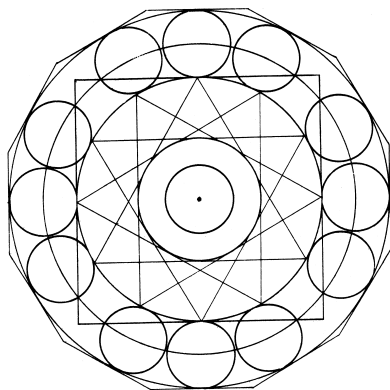
Between each appearance of random air-noise, please aim for maximum timbral diversity.

RANDOM WHISTLETONES

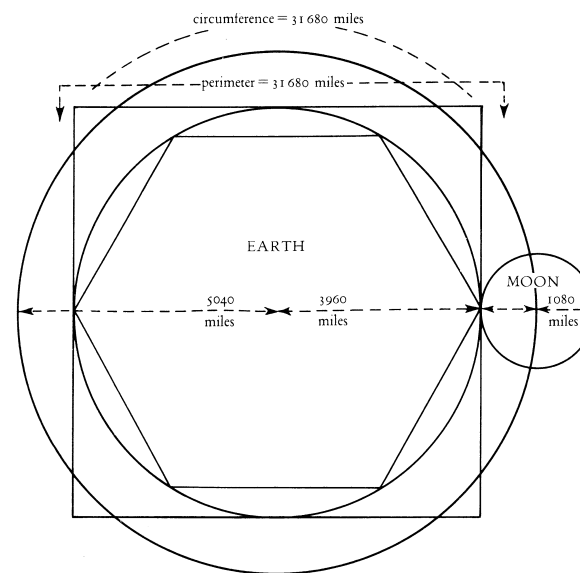
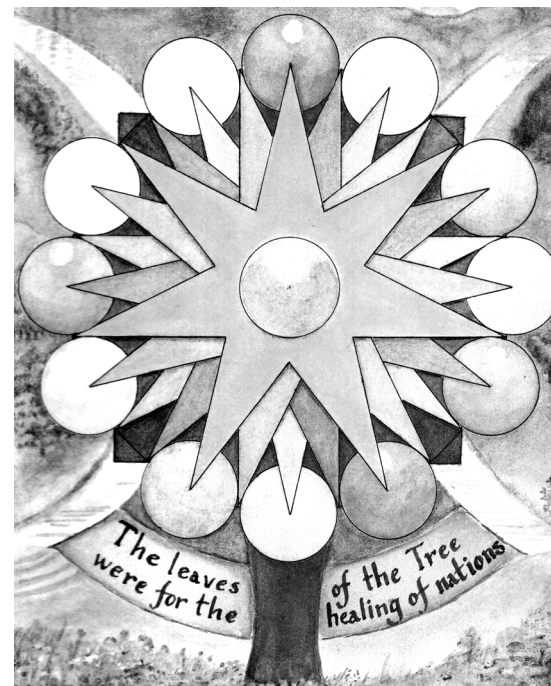


denotes *random whistletones*. Commencing in most cases with an aspirated attack, but always blowing as gently as possible across the embouchure-hole through a very narrow lip-aperture, vary the air-stream angle unpredictably in order to allow random sweeps and fluctuations of *pure* whistle tone pitches to materialize, roughly in accord with the dotted graphic contour. To assist in this irregularness of whistle tone pitch, randomly metamorphose their indeterminate fingering-configurations at any moment throughout the event as well – although such randomized finger-movement should not be particularly swift. As with random air-noise, please strive to *minimize key/mechanism-noise* (unless otherwise indicated) – so as to preserve the unsullied purity of the whistle tone sounds – while aiming nevertheless for maximum diversity between each occurrence of the whistletones.

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~ ix ~



~ x ~

KEY VIBRATI

roll out to correct flatness.

QUARTERTONES

roll in to correct sharpness.

roll in to correct sharpness.

roll in to correct sharpness.

MICROTONE SETS

Section 1

moderato

Section 1

MULTIPHONICS

Handwritten musical score for a section of a piece. The score is written on a single staff with a treble clef. It consists of several measures, each with a unique rhythmic pattern of notes and rests. The notes are mostly eighth and sixteenth notes. The score is divided into sections by vertical lines. The first section is labeled "section: 84". The second section is labeled "81". The third section is labeled "85". The fourth section is labeled "dynamic range" and includes a bracket indicating a range from "mf" to "pp-p". The fifth section is labeled "additional articulations" and includes a bracket indicating a range from "mf" to "pp-p". The score ends with a double bar line.

Dimensiones Paradisi

† with variation in breath-pressure and fluttertonguing/tongue-tremolo intensity, allow these multiphonics to break up and oscillate chaotically between, and through, their component tones.

Handwritten musical score for a string quartet, featuring four staves with complex notation, including accidentals, dynamics, and performance instructions.

Staff 1: Includes markings for $7:6^F$, $5:4^F$, and $3:2^F$. Dynamics range from (p) to f . Performance instructions include "accel...", "as fast as possible...", and "poco". A boxed β_5 is present.

Staff 2: Includes markings for $5:4^F$ and $5:3^F$. Dynamics range from ppp to f . Performance instructions include "accel...", "as fast as possible...", and "rit...".

Staff 3: Includes markings for $5:4^F$ and $5:3^F$. Dynamics range from ppp to f . Performance instructions include "accel..." and "(norm.)".

Staff 4: Includes markings for $7:4^F$ and $6:7^F$. Dynamics range from mp to f . Performance instructions include "mp: f non dim..." and "poco".

The score is heavily annotated with performance markings, including wavy lines for tremolos, slurs, and various dynamic markings such as ppp , p , mp , f , and pp .

Handwritten musical score for a single melodic line. The score is written on five staves. It includes various musical notations such as notes, rests, and dynamic markings. Above the staves, there are several diagrams: a 'K' with 'rit...' and a wavy line, a 'norm.' diagram with a trapezoid, and a box containing the number '2'. The score is annotated with performance instructions like 'Like freshly cut steel: extremely pure, brittle, bright, innocent ... glossolalia! (In one breath...)', 'Be still, statue-like...', and 'non dim., non cresc. - absolutely steady!...'. It also includes ratios like 5:4, 7:6, 5:3, 7:8, 8:5, and 3:2. The piece ends with a 'K' and a wavy line.

Like freshly cut steel: extremely pure, brittle, bright, innocent
... glossolalia! (In one breath...)

Be still, statue-like...

non dim., non cresc. - absolutely steady!...

† a complex random trilling action involving the D and/or D[#] trill-keys (speed: 'fast' to 'as fast as possible'). The presence of the four pitches in each trill should be statistically equal, each pitch appearing approximately 25% of the time, without any bias towards the initial pitch.

pale, lunar: one fluid gesture.†

rit...

7:8 $\frac{F}{\text{F}}$ 5:4 $\frac{F}{\text{F}}$ 7:4 $\frac{F}{\text{F}}$ 3:2

f mp pp mf mp f:pp-f ff p ff mp mf pp mp 3:7 4:3 13:9

norm

... from airiness, gradually coming into focus...

accel... as fast as possible...

13:9 7:10 2:3

p mp f

89. accel...

mf mp mf ff:mf pp f mf p:ff:mf mp f mf p:mp p mp

11:10 $\frac{F}{\text{F}}$ 5:11 $\frac{d}{\text{d}}$ 2:3 $\frac{F}{\text{F}}$

(mp) f p mp p pp ff! ppp f pp

accel... as fast as possible... accel... as fast as possible...

† see the footnote on p.1.

(as fast as possible...)

pppp p ff:mp pp p

accel...

mercurial: as fast as possible!

poco

mp: pp f mp mf > mp: f < > f

ppp p mf pp mp > pp < p mf pp mp mf < > pp

pale, lunar: one fluid gesture.†

mp f ppp p mp f p mf 5:4F 5:4F 5:4F 3:2F

7:5F 13:14F

† see the footnote on p.1.

[illegible]

Handwritten musical score system 1. It features a single staff with a treble clef and a key signature of one flat. The notation includes various note values, rests, and dynamic markings. Above the staff, there are vertical sequences of dots and circles, some with arrows pointing to specific notes. Below the staff, there are horizontal lines with dots and circles, some with arrows pointing to specific notes. The dynamic markings are: ppp!, f:ppp, f:mp, pp, f, ff:mp, ppp, <mp>, pp, mf:ppp, mp, mf:pp.

Handwritten musical score system 2. It features a single staff with a treble clef and a key signature of one flat. The notation includes various note values, rests, and dynamic markings. Above the staff, there are vertical sequences of dots and circles, some with arrows pointing to specific notes. Below the staff, there are horizontal lines with dots and circles, some with arrows pointing to specific notes. The dynamic markings are: mf, f, p, f, mf, p, mf, ff:pp, mf, f, sfz, p, mf, mp, f, p. There are also markings for 'a tempo', 'echo: mercurial, 'as fast as possible'', 'Kmmmm', 'A ~~~~~', 'mercurial...', and 'mercurial...'. There are also markings for 'poco', 'poco', 'poco', and '3/4'.

Handwritten musical score system 3. It features a single staff with a treble clef and a key signature of one flat. The notation includes various note values, rests, and dynamic markings. Above the staff, there are vertical sequences of dots and circles, some with arrows pointing to specific notes. Below the staff, there are horizontal lines with dots and circles, some with arrows pointing to specific notes. The dynamic markings are: (p), mf, pp, p, mf, ff:pp, mf, f, sfz, p, mf, mp, f, p. There are also markings for 'trmm', 'rand.', 'no air! tube resonance and mechanism noise only!', 'Be still, statue-like...', '3"', 'norm.', and '...from airiness, gradually coming into focus...'. There are also markings for '2/3', '7:6', '5:4', and 'f'.

Handwritten musical score system 4. It features a single staff with a treble clef and a key signature of one flat. The notation includes various note values, rests, and dynamic markings. Above the staff, there are vertical sequences of dots and circles, some with arrows pointing to specific notes. Below the staff, there are horizontal lines with dots and circles, some with arrows pointing to specific notes. The dynamic markings are: pppp! steady, unwavering..., p, mf, ff:ppppp. There are also markings for 'norm.' and 'f'.

[E] ♩ = 109.

[F]

pale, lunar: one fluid gesture.†

Be still, statue-like...

ff:mp 5:3 F 13:8 F mf:mp pp (accel...) f < ff 5:4 F sfz ppp: sfz: pp < p- mf

(omphalic!) (echo)

[E']

[α₇]

pale, lunar: one fluid gesture.†

mercurial...

ppppp p ↔ mp 13:8 F pp ppp ppp pp Be still, statue-like...

...from airiness, gradually coming into focus...

norm.

Be still...

p mp p

[D'] ♩ = 128.

[β₈]

tr as fast as possible...

Be still...

ff 5:4 F f mf < f ff:mf > p f mp

rit...

accel...

poco poco

mp: sfz: f p ff mp: sfz: f p mf

† see the footnote on p.1.

[illegible]

mp \rightarrow ff non dim... \rightarrow 6/7 \rightarrow poco \rightarrow 5:4 \rightarrow 5:4 \rightarrow 5:4 \rightarrow 7:4 \rightarrow 4:3 \rightarrow mp \rightarrow f \rightarrow mp \rightarrow sffz! \rightarrow f \rightarrow p \rightarrow fff \rightarrow ff:mf

norm. \rightarrow

Be still, statue-like... \rightarrow pppppp \rightarrow p \rightarrow mp \rightarrow p: pppp! steady, unwavering... \rightarrow p \rightarrow mf \rightarrow p

to airiness, gradually losing focus...

no air! tube resonance and mechanism noise only!

Be still, statue-like...

pale, lunar: one fluid gesture.

ppppp... \rightarrow x \rightarrow o

sffz \rightarrow p \rightarrow pp \rightarrow ppp

7:10 \rightarrow 13:9 \rightarrow 4:3 \rightarrow 5:4 \rightarrow 7:4 \rightarrow 17:12 \rightarrow fff

as fast as possible...

poco

(p \leftrightarrow mf) \rightarrow pppp! mp \rightarrow mf: p \leftrightarrow mf \rightarrow p \rightarrow mf \rightarrow mf \rightarrow ff \rightarrow f \rightarrow fff

† see the footnote on p.1.

B₆

Handwritten musical score for a single melodic line, featuring various dynamics, articulations, and performance instructions.

Staff 1: Starts with a tremolo marked "as fast as possible...". Dynamics range from *ppp!* to *f*. Includes a section marked "17:12.F" and a "non dim..." instruction.

Staff 2: Features a section marked "warm, muted..." and another marked "mercurial...". Dynamics include *ff*, *fff*, *mf*, and *p*. Includes a "poco" marking.

Staff 3: Includes a section marked "rit..." and another marked "as fast as possible...". Dynamics range from *sfz* to *pp*. Includes a "poco" marking.

Staff 4: Ends with a section marked "Be still...". Dynamics range from *f* to *pp*. Includes a "poco" marking.

Performance Instructions: The score includes numerous handwritten notes such as "accel...", "warm, muted...", "mercurial...", "rit...", "as fast as possible...", and "Be still...". It also features various musical notations like slurs, ties, and dynamic markings.

...glossolalia! (In one breath...)

Somewhat diffuse and woolly: distant, impersonal, detached...
...glossolalia! (In one breath...)

15"!

Be still, statue-like... pppppp... ppp non dim., non cresc. - absolutely steady! ...

rand. random...

monolithic: cloyingly lyrical...

mercurial... Be still, statue-like! f: pp! mp p ff non dim...

ppppp... (ff...) mf ff non dim... ppp

accel...

† see the footnote on p.3.

8

2

Handwritten musical score with multiple staves and dynamic markings.

Dynamic markings include: *mf*, *ff*, *mp*, *mf: p*, *poco*, *mp > p*, *ff!*, *stffz: f*, *mf*, *ppp*, *fff*, *p*, *mp*, *pp*, *fff*, *f*, *pp!*, *ff*, *p*, *fff*, *ff non dim...*, *mf*, *ff*, *poco*, *poco*, *ff non dim...*, *mp*, *mf*, *poco*, *poco*, *poco*, *ff*.

Performance instructions include: *Be still, statue-like...*, *as fast as possible...*, *rit...*, *accel...*, *mercurial...*, *5:4 F*, *3/4!*, *7:5 F*.

Other markings include: *5''*, *(✓)*, *(ff...)*, *(-)*, *Ⓟ*.

Handwritten musical score for a single melodic line, featuring complex rhythmic patterns, dynamic markings, and performance instructions.

Section 1 (Top):

- Starts with a treble clef and a key signature of one flat (B-flat).
- First staff: $\text{fff} \rightarrow \text{sffz} : \text{ppp!}$ (with a circled '4') $\rightarrow \text{f poco} \rightarrow \text{f poss! non dim...}$
- Second staff: $\text{mf} \rightarrow \text{pp} \leftrightarrow \text{mp}$ (with a circled '4') $\rightarrow \text{mf} : \text{pppp! echo: steady, unwavering.}$ (with a circled '1') $\rightarrow \text{pp} \leftrightarrow \text{mp}$
- Third staff: $\text{mf} : \text{p poss. non cresc! ...}$
- Annotations: "accel..." (wavy line), "as fast as possible..." (wavy line), "quicksilver! (legatissimo poss.)", "pale, lunar: one fluid gesture." (with a dagger symbol †).
- Time signatures: $5/3$, $4:3$, $13:14$.

Section 2 (Middle):

- First staff: $\text{mf} \rightarrow \text{pp} \leftrightarrow \text{mp}$ (with a circled '4') $\rightarrow \text{f poss!}$ (with a circled '9') $\rightarrow \text{f}$ (with a circled '3:2') $\rightarrow \text{poco}$ $\rightarrow \text{p}$ $\rightarrow \text{pppp} : \text{sfz} : \text{pp}$ $\rightarrow \text{ffff}$ $\rightarrow \text{f poss! pure!}$
- Second staff: ppppp...
- Annotations: "warm..." (wavy line), "as fast as possible..." (wavy line), "do not pause!" (with a circled 'P') \rightarrow "Music of the Spheres": bursting upwards, through crystal orbits..." (with a circled 'H') \rightarrow "norm." (with a circled 'H') \rightarrow "highest possible pitch" (with a circled 'P') \rightarrow "sustain the whistle tones until all breath is depleted..." (with a circled 'P') \rightarrow "echo." (with a circled 'P') \rightarrow "Be still, statue-like..." \rightarrow "cease finger activity..."
- Time signatures: $3:2$, $c.8''$.

Section 3 (Bottom):

- First staff: norm. (with a circled 'G') \rightarrow $\text{= } 87.5.$ (with a circled 'G') \rightarrow f poss! (with a circled '9') $\rightarrow \text{f}$ (with a circled '3:2') $\rightarrow \text{poco}$ $\rightarrow \text{p}$ $\rightarrow \text{pppp} : \text{sfz} : \text{pp}$ $\rightarrow \text{ffff}$ $\rightarrow \text{f poss! pure!}$
- Second staff: ppppp...
- Annotations: "sustain the whistle tones until all breath is depleted..." (with a circled 'P') \rightarrow "echo." (with a circled 'P') \rightarrow "Be still, statue-like..." \rightarrow "cease finger activity..."
- Time signatures: $c.8''$.

† see the footnote on p.1. ‡ treat this accelerating group of grace-notes as a single spectrally evolving envelope; yet allow each harmonic to be established individually. Then without any caesura whatsoever, employ the strongest possible attack to articulate the high D^{\sharp} ; fully sustain this tone (with maximal purity!), merging it as smoothly as possible into random air-noise.

Duration: c.10'
Relax!
FINE.
J. J. Mander.
Sydney, Australia
31.8.98.
Dimensiones Paracelsi

CHAPTER 9. FINAL REMARKS

9.1 SPECULATIONS AND CONCLUSIONS

‘Metaspeculations’

It strikes me as somewhat dubious for any composer – particularly one who is still, I imagine, quite a long way from the end of his creative life – to be put in the position of having to prognosticate about his future compositional output: to do so, surely, is to indulge in the fiction that one might actually be some kind of omniscient divinator; one is also compelled, perhaps, to divulge methodological secrets; and to one’s eternal embarrassment (now that the record must be ‘hewn in stone’), experimental techniques about which one has gushed enthusiastically herein might never yield fruit. Even worse ... to be told to bracket together much of one’s compositional *œuvre* to date, thence to draw meaningful conclusions about it: posterity, with the dual benefits of distant hindsight and ‘dispassionate engagement’, eventually reaches much more proper verdicts regarding works of art (and their historicity) than the art-works’ originators ever could – however well-intentioned they might be. Nevertheless, such fanciful journeys of the imagination – even if they are problematic, full of discomfort or anxiety, and are at best provisional – can still be illuminating. Therefore, I propose to taxonomize several (but by no means all) of my own composerly speculations, below, in a manner which is comparable to the ordering of topics within section 1.2 – since these speculations (many of which shall be effectuated through my next major work, **Gate of Remembrance: 12 Hypostases**) are all outgrowths of my recurrent compositional techniques:

Systematic Permutation (from section 1.2.1)

As within my **Lines of Light: Seven Improvisations on αιθερος μελος**, I do intend to continue researching the application of more than just one cyclic group of permutations within a piece of music.¹ **Lines of Light**’s two cyclic groups are brought to bear upon quite different types of musical object from within the time domain – namely, duration and ‘pitch-reservoirs’. In my forthcoming large-scale piano piece **Gate of Remembrance: 12 Hypostases**, though, two distinct cyclic groups of permutations will instead rearrange disparate durations, all of them belonging to the *same* class of temporal objects.²

And yet another source of permutivity, of which I am yet to make any real musical use, resides in the larger – albeit less unific – category of (not necessarily cyclic) *permutation*

groups: given some ordered set Σ consisting of n elements, the set of *all* $n!$ permutations of Σ is known as the *symmetric group* Σ_n ; hence, one could simply select some appropriate permutation *subgroups* of Σ_n which in themselves will either be cyclic or non-cyclic in their algebraic structures (the cyclics being generated through reiterating upon itself, ‘multiplicatively’, just a *single* permutation).³

Virtual Structures (from the final paragraph of section 1.2.3)

Near the close of section 1.2.3, while mentioning my **Dimensiones Paradisi**’s pitch-gamuts (and their ‘statistical biases’ in particular), we do begin to perceive the origins of *virtual structures* – since these pitch-gamuts’ extrema might never be sounded and gamuts belonging to ‘statistical biases’ are, essentially, implied. But what I have in mind here instead is a slightly different kind of virtuality: musical ground-plans – indeed, formal metaphors of panentheism – that are both immanent (as ‘real presences’) *and* transcendent: “[geometrical] schemata that extend beyond the corporeal manifestation of the artwork itself”.⁴ Thus, a composition which embraces this idea reifies only a portion of the geometries that undergird it; the remainder consists of ‘virtual structures’ inferred from the formal geometric data actually present within the music itself. For instance, my still-incomplete **Gate of Remembrance: 12 Hypostases** sprawls over an involuted gamut-network spanning eleven octaves, upon which the somewhat narrower range of the piano has been superimposed; likewise, this work’s proportional chronomorphology is merely a ‘snapshot’ of – an excised sample from – a much vaster geometrico-temporal edifice.

Whence, for me, did this exquisite principle of structural virtuality emerge? While I was reading John Michell’s seminal book **The Dimensions of Paradise: The Proportions and Symbolic Numbers of Ancient Cosmology** more than a decade ago, I came across a passage therein (*ibid.*, pp.82–89) that comprehensively analysed Albrecht Dürer’s unforgettable engraving of 1514, **Melencolia**, which depicts

a winged, dark-visaged, brooding figure, seated amid apparatus of geometry and masonic crafts. The picture is crammed with symbolism, and the question of what Dürer meant by it has given rise to a vast literature. ... [However, Franz Deckwitz’s] pioneering [interpretative] efforts open the way to a fuller understanding of **Melencolia** through the symbolism of the geometric types underlying it. Building on [this] work [by Franz Deckwitz], it becomes possible to establish with some confidence the nature of Dürer’s geometric and numerical statement. ...⁵

Deckwitz’s and Michell’s analyses show that, based upon specific lines, curves, and points located *within Melencolia*, certain pentagonal, hexagonal and circular shapes are insinuated whose perimeters reach out partially *beyond* the borders of Dürer’s famous artwork. Such a puissant and breathtaking concept immediately suggested to me its direct

applicability to music; so, my **Gate of Remembrance: 12 Hypostases** shall be the first piece from my ever-expanding *œuvre* to explore this panentheistic mode of formal virtuality.

Universal Constants, Proportionality, and Magic Squares (from section 1.2.4)

Elsewhere in **A World of Becoming**, I have given much attention to those archetypic irrational constants $\sqrt{2}$, $\sqrt{3}$, π , e , and Φ – particularly in their rôle as numerical proportioners. Such constants are truly universal, in that they subsist immutably – independent of any unit of measure; they are not at all contingent upon physical reality.⁶ Another such ‘universal number’ which I do propose to employ within my music, but have not done so as yet, is *Feigenbaum’s constant*: $\delta \approx 4.6692016091029$.⁷ δ is named after the physicist Mitchell J. Feigenbaum, who, during the late 1970s, was one of the very first researchers of non-linear maps to recognize δ ’s mathematical attributes. Technically, δ characterizes the parameter values p for which the recursive *quadratic* (or *logistic*) map $x_{n+1} = p \times x_n \times (1 - x_n)$, for instance, experiences a bifurcative phenomenon known as ‘period doubling’ – when $0 \leq x_0 \leq 1$ and $0 < p \leq 4$.⁸

... δ is a *universal* constant, the famous (and probably transcendental) Feigenbaum constant (originally found by S. Grossmann and S. Thomae [in 1977] ...). This magic number has earned the epithet “universal” because it applies, as Feigenbaum has shown, to many different nonlinear maps, independent of the details of the mapping, as long as the absolute maximum of the mapping is quadratic. ...⁹

... while [Mitchell J. Feigenbaum was] researching an entirely different [non-linear recursive] model, $x_{n+1} = a \times \sin(\pi \times x_n)$, he found not only the same [period-doubling behaviour as occurs with the quadratic map], but also exactly the same [δ]-value [of ≈ 4.6692016091029]. In brief, it became obvious that this was a *universal* phenomenon that always occurs whenever there is repeated period doubling. [δ] is a universal constant, just like π or e , the base of the natural logarithms. [δ] has been called *Feigenbaum’s number* ever since. Once this became generally known, the same number was found in various experiments in physics that all have a so-called phase transition in common. The behavior of helium near absolute zero is an example of this. All of this demonstrates beautifully that seemingly pure mathematical research, computer experiments, and physical reality are in fact intimately related.
...¹⁰

Concerning musical proportionality in general, I can envisage a number of possible future directions for my work. Within section 1.2.4, I have already cited the music of Chris Dench, who ‘smears’ sets of proportional values across architectonic strata – thereby creating a new compositional parameter of variable (in)accuracy regarding formal self-similarity. We thus perceive now the exciting potential to transform, homeomorphically, one set of proportions into another set – either synchronously or diachronously. I would also like to consider introducing some random perturbations – stochastic flaws or ‘errors’ –

into my refined, proportionally self-similar schemata. Why? Such an act of apparent subversion could well transmute a ‘mathematically correct’ fractal-like musical structure into something that seems even more natural and physically real:

The concept “fractal” has already proved its use in many applied fields. There one often feels the need to extend the concept of [self-]similarity to some degree by introducing small changes into the series of similarity transformations, so-called disturbances. If we introduce chance disturbances into a mathematically regular tree fractal the result may look like a real tree, coral, or sponge. ...

The fractals we have looked at so far have [all] been too beautiful, really, too strictly mathematical. They have had perfect self-similarity, as we can see in the von Koch curve ... [which] we compared ... with a coastline, like the west coast of Britain. In reality, though, coastlines are created by the whims of nature; chance is at work in this creative process. If we interpret self-similarity not in the exact sense, but statistically, we get more realistic fractals. To do this we require each part of the fractal to have the same statistical properties of form. The mathematical theory underlying such stochastic fractals is far from simple, ...¹¹

Dr Hans A. Lauwerier here speaks of *statistical* self-similarity, whereby general behaviours or tendencies, rather than *precise* proportionalities, are replicated across structural tiers: “... It comes down to the fact that the *statistical* properties of each part, however small, do not depend on the scale [of observation]. ... Following [Benoît B.] Mandelbrot, we can now extend the concept of ‘fractal’ to a [multilevel] geometrical structure with statistical self-similarity. ...”.¹² Such an approach to formal organization may well prove to be extremely valuable in my ongoing composerly striving after ever-greater musical complexity, organicism, and naturalness – which should, nevertheless, fail to undermine compositional unity.

One means of ‘serializing’ proportional quantities (or, for that matter, any other musical materials) that I shall utilize within my **Gate of Remembrance: 12 Hypostases** – and indeed have already wielded, albeit covertly, within my **153 Infinities** – embraces *magic squares*: a magic square is an $n \times n$ array of numbers 1, 2, 3, ... , k , ... , n , $n+1$, $n+2$, ... , n^2 whose columns, rows, and long diagonals all sum to exactly the same value – the so-called ‘magic-square constant’.¹³ Magic squares are, it seems, unusually fertile in symbolism – with certain specific magic squares (and numbers n) being closely associated with celestial objects from our solar system, among other things:

Magic squares [are quadratic] arrangements of whole numbers in such a way that the sums of files, ranks, and [long] diagonals are [all] equal to one another; they played an important role as early as in ancient mathematics – also in the Far East. In astrology, a particular magic square was associated with each planet, which is why one speaks of “planet seals”. Magic squares having 3 (9 total numerals), 4 (16 total numerals), 5 (25 total numerals), 6 (36 total numerals), 7 (49 total numerals), 8 (64 total numerals), and 9 (81 total numerals) [numbers] on each outer edge, were of particular importance; as planet seals, they corresponded to Saturn (*Sigilla Saturnis*),

[to] Jupiter (*Sigilla Jovis*), [to] Mars (*Sigilla Martis*), [to] the sun (*Sigilla Solis*), [to] Venus (*Sigilla Veneris*), [to] Mercury (*Sigilla Mercuris*), and [to] the Moon (*Sigilla Lunae*). The Jupiter [magic] square became especially well known because it was used by Albrecht Dürer in his famous etching **Melencolia** ... In conjunction with the symbolism of numbers and letters [i.e. *gematria*] ..., number squares could also be written in letters. ... Magic squares were once viewed as an expression of the harmony between the astral world and that of the “magician”, and were reflected in ideas about the Microcosm-Macrocosm. ...

Of the infinitely large number of magic squares, those of the form n^2 ($n = 3$ [to] 9) play a special role. The $[2 \times 2]$ magic square cannot be constructed due to mathematical reasons and is thus assigned to unordered chaos. In contrast, the other [magic] squares from $[3 \times 3]$ to $[9 \times 9]$ are assigned to the planets, the sun and the Moon in the Chaldean order (Saturn, Jupiter, Mars, sun, Venus, Mercury, Moon). The origin of magic squares should possibly be sought in India; they probably came to Europe via Arabia.¹⁴

Symmetry-Breaking and Structural Ambiguity (from section 1.2.5)

As one will have gathered from the foregoing ‘speculations’, the fracturing of symmetries as well as processual disruption – in imitation of nature – are sure to remain high on my list of compositional priorities. One of my spheres of interest here is intricate sectional forms whose structural boundaries are not at all clear-cut: contiguous (sub)sections may be permitted to interpenetrate one another in various ways so that ambiguous ‘transitional zones’ result. This idea, wherein continuity tends to take precedence over juxtaposition, is by no means original. In Javanese *gamelan* music, for instance, one often experiences such a sense of ‘proprioceptive disorientation’ when the drummer signals a change of *irama* (i.e. beat-unit or tactus): a brief, rather chaotic-sounding intermediate region prevails before the music’s patterns fully restabilize.¹⁵ Just as the fingers of one’s hands are able to touch, to be entangled or locked together in a multitude of shapes (or instead, one’s fists can abut against each other, block-like), I know by instinct and by analogy that all manner of delicious structural ambiguities could be attained within my future compositions.

Figurate Numbers and Geometric Forms as Generators of Durational Patterns (from section 1.2.11.1, section 1.2.5 and section 8.1)

A World of Becoming is replete with examples of ‘polygonal durations’ – and also (in **Dimensiones Paradisi**) of a chronomorphology moulded by the analysis of areas between various geometrical shapes that comprise a prototypic mandala-like object. Combining these two temporal methodologies within a single piece intermeshes a ‘geometric metaphor’ with its actual form, so that the shape itself becomes a catalyst for resolving ostensibly diverse musics into glorious unity. Yet in both cases, the geometries involved are merely planar – two-dimensional. One may, however, extend these ideas by invoking

solid, multidimensional, or even non-Euclidean geometries: it is possible to procure figurate numbers from *polyhedra* or indeed from *polytopes* (in four or more dimensions), from which sets of ‘figurate durations’ could be fashioned; and, by extrapolating into at least three dimensions the concept of a planar, entelechial ‘mandala’, I plan to survey the relative volumes or surface areas of concentric spheres and the regular, Platonic solids¹⁶ – and perhaps, too, their hyperspatial counterparts, in higher dimensions – as potential arbiters of time ... in a holy matrimony between music and sacred geometry.

On Musical Media – ‘Old’ and ‘New’

In the closing paragraph of my **Manifesto** (reproduced as Appendix 1 herein), I declare that:

... As a practitioner of music in many of its aspects, I discern a grand continuum between all – a unity. For me, each aspect informs the others. Focussing here specifically upon performance and composition, my detailed and far-reaching researches into the acoustical capabilities of the recorder (and their realization in performance), provide a natural creative basis for considering the full range of technical resources of every instrument for which I compose. ...

So I conjecture that my research into ‘extended instrumental techniques’ and microtonality – in particular: microtonal pitch-sets that spring straight from an instrument’s physiology or mechanism – will remain quite prominent within my compositional agenda. Moreover, it is my intention to resume exploration of electroacoustic sound-worlds (after I have purchased a more powerful, up-to-date computer system) and start composing some ‘acousmatic music’¹⁷ through direct digital synthesis and signal-processing on my computer. Revelations such as these emanate from my need – as the composer Chris Dench so aptly puts it – to make manifest

... a particular vision, an envisaged musical domain that is, for [this] composer, unendurably absent from the expanding musical universe. This vision is not just of a ‘piece of music’, but of a whole territory of musical utterance of which the work in hand is [only] a specific instance. ...¹⁸

I do seem to be obsessed with the endless search for ‘virginal timbres’, being perpetually driven to forge my own individual sonic landscape within an ever more distinctive and recognizable compositional idiolect.

Conclusions?

It could well be argued that my speculations alone – which, in regard to my future *œuvre*, elucidate both the potential fecundity of certain of my recurrent compositional techniques, and (by omission) the utile boundaries of others – constitute, *ipso facto*, a

sound conclusion to **A World of Becoming**: verdicts have already been reached, and a process of scholarly research, erudition and learning (which continues to gather momentum) demonstrated. Still, though, a few stray points that ought to be made do linger; these observations are in the nature of ‘composerly progressions’ identified, and pitfalls avoided – all of which I have gleaned about my work through rigorous self-scrutiny.

Looking back, I sensed that during the late 1980s, my composing had perhaps begun to falter through the deployment of (extended) instrumental techniques purely as acoustical ‘effects’ – and rather indiscriminately at that – to sculpt the surface of my music: I was then in grave danger of succumbing to compositional shallowness via timbral superficiality. Ever since, I have tried to skirt around the trap of writing music that relies excessively upon foreground gesturality instead of integrated musical depth. Hence, one can discern in my music from **A World of Becoming** a meandering trajectory away from things cosmetic into organic structural unities ... towards a coalescence of form and content, as consummated by the final work herein, **Dimensiones Paradisi**. In parallel with this maturation, I increasingly shun palpable repetitiveness and naïve beat-based temporalities. Sweeping onward from the corporeal rhythms and cyclical repetitions of **Solar Dust: Orbits and Spirals**, **Arcturus Timespace** and **Cycles of Vega**, I find it deeply satisfying – and all too characteristically human – that, like the end of a good life, the last musical utterance of **A World of Becoming** (viz., the dénouement of **Dimensiones Paradisi**) is truly a *religatio*: a ‘binding back to the source of things’; an ‘ascension to Heaven’ – a return to the archetypal ‘World of Being’, thence beyond into ultimate silence *in caelo*.

Throughout **A World of Becoming**, there is a gradual summoning of focus upon one goal: it is what the Japanese call *shibui* – wherein beauty attains great subtlety, a restrained yet complex elegance, such that a piece of music possesses a timeless balance of contraries ... the unification of *yin* and *yang*:

... To which I append my own aphoristic ‘apologia’: “diversity embraced in *unity* – *rapprochement* and interreferentiality in deep conceptual abstraction, beyond superficial, fictitious dualisms”.

Ostensible dichotomies – chimerical polarities (some of which are merely endpoints of continua) – reconciled into unity through my piece **Gate of Remembrance: 12 Hypostases**, include: the physical (‘reality’) and the metaphysical (‘suprareality’); corporeal structure (immanence) and incorporeal structure (transcendence); systemics (rational, processual ... ‘Mind’), nonsystemics (instinctual, intuitive, suprarational, non-algorithmic ... ‘Heart’) and ‘semisystemics’ – through *gnosis* and pattern; Order (*analogia*) and Chaos (*anomalía*); memory, forgetfulness and unforeseeability; Nature (of the Universe) and Culture (from Humanity); Macrocosm, Mesocosm, and Microcosm – through Hermetic Philosophy, fortified by the Holographic Paradigm and the mathematics of Fractals (both of which exhibit multilevel architectonic self-similarity); sacred (celestial, mystical) and profane

(terrestrial, mundane); Sun (666 {The Beast}, a 6×6 magic square, Man) and Moon (28, 1080 {≈ To 'Αγιον Πνευμα, "The Holy Spirit"}, a 9×9 magic square, Woman); movement (activity, teleology, 'becoming') and repose (stasis, goallessness, 'being'); 'linear time' and 'circular time'; symbol (the esoteric) and object (the exoteric); polygonal geometries of various orders; diverse permutations – as elements of abstract, self-contained, autopoietic Cyclic Groups ... 'finite infinitudes'; complementary pitch-sets and their union in the referential set (the 88 keys of a grand piano as 'Universe'); (meta)pulse and the obscuration or absence of pulse (e.g. "logarithms", through to entirely beat-free durational schemata); synchronous and diachronous constructs; various time-scales (pitch-reservoirs and chronomorphologies); foreground-, middleground-, and background-resonances – textural veils unique to the piano; sound and silence...

For me, this piece *is* the whole Cosmos.¹⁹

I do contend that, through at least a handful of my original compositions within **A World of Becoming**, I have succeeded in erecting some sort of bridge between the World of the 'real' and the World of the *REAL* – and in so doing, I clasp to myself the profound unity that is *shibui*.

*... predestination to the labyrinth.
An experience of seven solitudes.
New ears for new music.
New eyes for what is most distant.
A new conscience for truths ...*

– Friedrich Nietzsche: from the **Preface** to **The Antichrist**.²⁰

DEO GLORIA

ENDNOTES

1. Such cyclic groups may – or may not – be algebraically related.
2. I see this situation as being analogous to the serial pitch-organization in Igor Stravinsky's **Requiem Canticles** (1965–1966), which engages *two* (loosely cognate) dodecaphonic series. See Spies (1967), for example.
3. Herstein (1975), pp.75–82.
Cayley's theorem (*ibid.*, pp.71–75) proves that *every* finite group is isomorphic to some permutation group. Thus, each cyclic group may be treated algebraically as a permutation group; but the converse of this statement is decidedly false – there exist numerous permutation groups which do *not* possess a cyclic-group construct. Anyway, I do hope to investigate the musical merits of *non*-cyclic permutation groups within some of my future compositions.
4. See Shanahan (1995), reprinted herein as Appendix 2.
5. Michell (1988), p.82.
Udo Becker – in Becker (1996), p.192 – claims that iconographically, Dürer's **Melencolia** "... is regarded as the visual culmination of a humanistic apology of human freedom of the will and of virtuous striving for knowledge that establishes an elaborate relationship between mathematics, astronomy, and astrology (such as [the] Platonic Solids, [and] Magic Squares), a relation that ultimately leads to a divine unity".
6. Therefore, the use of physical quantities like *Planck's constant* $h = 6.6261 \times 10^{-34} \text{ m}^2 \text{ kg s}^{-1}$ (employed in connection with the quantization of electrons' angular momenta) as constants of structural proportionality, is automatically ruled out: h will change according to the units of length, mass and time that one selects.
7. Actually, I had wished to engage δ as a proportional determinant within **[p]s(t)ellor/mnême**; however, throughout the period of its composition, my first-edition copy of Ian Stewart's book **Does God Play Dice? – The New Mathematics of Chaos** (which I then believed to be my only source of information on the value of δ) was on long-term loan to a colleague, Kala Perkins, who at the time was uncontactable.
8. Feigenbaum's constant δ is discussed at length in Schroeder (1991), pp.268–295 (and *passim*); consult also Lauwerier (1991), pp.116–122, Mandelbrot (1983), and Stewart (1997), pp.181–200 (and *passim*).
9. Schroeder (1991), p.275.
10. Lauwerier (1991), p.120.
11. *ibid.*, p.xiii & p.104.
12. *ibid.*, p.113.
13. Benson & Jacoby (1976) study the mathematical properties of magic squares. Concerning their cultural semiology, however, I recommend that one should read Michell (1983), p.124, p.161 & p.195, and Pennick (1988), pp.157–160.
Perhaps it is also timely for me to correct a musicological misconception – or gross injustice? – about magic squares: the celebrated English composer Peter Maxwell Davies is quite well-known for the application of magic squares to his own music; yet he is in fact preceded in this by the New-Zealand-born Australian composer Gillian Whitehead. Many years ago, during a long telephone conversation, Gillian Whitehead told me that indeed she had introduced the basic concept and astrological imagery of magic squares to Peter Maxwell Davies, through John Michell's book **The View over Atlantis** (*ibid.* – but in some earlier edition) which was first published in 1969.
14. Becker (1996), pp.184–186.

15. This observation is made purely on the basis of my own personal experience – as one who has played both the *slentem* (a large trough metallophone) and the double-headed drum in a Javanese *gamelan*, at the University of Sydney, during 1987.
16. In 3-space, there exist only five *Platonic solids* – or convex *regular polyhedra*: the *tetrahedron* (which has four triangular faces); the *cube* (with its six square faces); the *octahedron* (having eight triangular faces); the *dodecahedron* (which displays twelve pentagonal faces); and the *icosahedron* (possessing twenty triangular faces). These ‘perfect’ solids played a significant rôle in Ancient Greek geometry, being first described by Plato within his **Timaeus**. Also, the seventeenth-century German astronomer and mathematician Johannes Kepler modelled our solar system’s orbital mechanics upon nestings of the Platonic solids.
17. ‘Acousmatic music’ is the most current jargon for electroacoustic music that has been especially composed for, and resides entirely within, some digital sound-media (such as Digital Audio Tape [DAT] or Compact Disc [CD]); it supersedes the rather ambiguous terminology ‘computer music’, given the ubiquity of computers nowadays.
18. Chris Dench: “... ‘the composer becomes a cartographer’ ...”; in ed. Broadstock (1995), p.287.
19. **Gate of Remembrance: 12 Hypostases**, Programme Annotation {forthcoming}.
Although **Gate of Remembrance: 12 Hypostases** is of course not a part of **A World of Becoming**, this programmatic excerpt does encapsulate many of my unific composerly preoccupations canvassed herein.
20. ed. Kaufmann (1976), p.568.

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THE ACCOMPANYING COMPACT DISCS:

TRACK LISTINGS AND DETAILS

* NB: *whenever one of my compositions from **A World of Becoming** is represented by more than one recording herein, an asterisk (*) indicates that track of it with which I am most satisfied.*

COMPACT DISC 1

TRACK 1: Arcturus Timespace (1987/1994), for soloist (amplified mandolin and percussion) and 'tape', with optional light- and image-projection.

Stephen Morey – soloist (amplified mandolin and percussion).

Computer-generated stereophonic tape part produced at the Sydney University Experimental Sound Studio [SUESS], Department of Music, the University of Sydney, under the direction of Ian Fredericks.

Recorded at 2MBS-FM (Studio C), St Leonards, Sydney. n.d. {Digital Master}

Producer: Ian Shanahan.

Sound Engineer: Graham McDonald.

Digital Remastering, EMI Studios 301, Sydney: Martin Bengé, 20.5.1991.

Digital Editing and Denoising: Julian Knowles, the University of Western Sydney (Nepean), Kingswood, Sydney, 30.9.1998.

Duration: 11'.41"

TRACK 2: Cosmos (One Note) (1987/1997), for solo Yamaha DX7 keyboard synthesizer.

Ian Shanahan – Yamaha DX7 keyboard synthesizer.

Recorded at the Main Studio, Music Department, School of Contemporary Arts, the University of Western Sydney (Nepean), Kingswood, Sydney, 15.2.1999. {Digital Master}

Producer: Ian Shanahan.

Sound Engineer: Adrian Luca.

Duration: 6'.20"

TRACK 3: Solar Dust: Orbits and Spirals (1988/1999), for solo (amplified) mandolin.

Paul Hooper – mandolin.

Recorded at the Australian Broadcasting Corporation [ABC] Studios, Chatswood, Sydney, 30.11.1988. {Analog Master}

Producer: David Hinder.

Sound Engineer: unknown.

Digital Editing and Denoising: Julian Knowles, the University of Western Sydney (Nepean), Kingswood, Sydney, 30.9.1998.

Duration: 9'.38"

TRACKS 4–8: Five Études (1988–1991), for solo recorder.

TRACK 4: Helical Ribbon (1990), a terse étude for alto recorder.

Ian Shanahan – alto recorder.

Recorded at EMI Studios 301, Sydney, 21.6.1990. {Digital Master}

Producer: Robert Allworth.

Sound Engineer: Martin Bengé.

Digital Remastering and Denoising, EMI Studios 301, Sydney: Stephen Smart, 22.6.1999.

Duration: 0'.34"

TRACK 5: *Lingua Silens Florum* (1991), a garland for prepared alto recorder.

Ian Shanahan – prepared alto recorder.

Recorded at EMI Studios 301, Sydney, 27.11.1991. {Digital Master}

Producer: Robert Allworth.

Sound Engineer: Martin Bengé.

Digital Remastering and Denoising, EMI Studios 301, Sydney: Stephen Smart, 22.6.1999.

Duration: 0'.57"

TRACK 6: *Cathy's Song* (1988), an encore piece for sopranino (or alto) recorder.

Ian Shanahan – sopranino recorder.

Recorded at EMI Studios 301, Sydney, 21.6.1990. {Digital Master}

Producer: Robert Allworth.

Sound Engineer: Martin Bengé.

Duration: 0'.53"

TRACK 7: *Dysfunctional Habañera* (1990), for alto recorder.

Ian Shanahan – alto recorder.

Recorded at the Main Studio, Music Department, School of Contemporary Arts, the University of Western Sydney (Nepean), Kingswood, Sydney, 15.2.1999. {Digital Master}

Producer: Ian Shanahan.

Sound Engineer: Adrian Luca.

Duration: 0'.30"

TRACK 8: *Graeme Petrie, scallywag* (1990), for alto recorder.

Ian Shanahan – alto recorder.

Recorded at the Main Studio, Music Department, School of Contemporary Arts, the University of Western Sydney (Nepean), Kingswood, Sydney, 15.2.1999. {Digital Master}

Producer: Ian Shanahan.

Sound Engineer: Adrian Luca.

Duration: 0'.40"

*** TRACK 9: *Cycles of Vega* (1988–1991), for sopranino clarinet in e♭ and percussion (2 players).**

Roslyn Dunlop – e♭ clarinet; Daryl Pratt and Tony Cowdroy – percussion.

Recorded at the Sydney Conservatorium of Music, Sydney, 10.1.1992. {Digital Master}

Producer: Ian Shanahan.

Sound Engineer and Digital Editing: Greg White.

Digital Remastering, EMI Studios 301, Sydney: Stephen Smart, 15.3.1994.

Duration: 10'.42"

TRACK 10: *Cycles of Vega* (1988–1991), for sopranino clarinet in e♭ and percussion (2 players).

Peter Jenkin – e♭ clarinet; Daryl Pratt and Richard Gleeson – percussion.

Recorded live, by the ABC, during a concert given by the ensemble *australYSIS* as part of the Tenth Sydney Spring International Festival of New Music, at The Studio, the Sydney Opera House, Sydney, 2.9.1999. {Digital Master}

Producer: Ralph Lane.

Sound Engineer: Dennis Fox.

Digital Editing and Denoising: Adrian Luca, the University of Western Sydney (Nepean), Kingswood, Sydney, 21.12.1999.

Duration: 11'.01"

TRACK 11: Lines of Light: Seven Improvisations on *αιθερος μελος* (1991/1993), for amplified recorders (1 player), two Yamaha DX7 keyboard synthesizers (1 or 2 players), and metallic percussion instruments (1 or 2 players).

Ian Shanahan – amplified recorders; Roger Dean – two Yamaha DX7 keyboard synthesizers; Daryl Pratt – percussion.

Recorded live during a concert given by the ensemble *austraLYSIS*, at the Joseph Post Auditorium, the Sydney Conservatorium of Music, Sydney, 27.11.1993 [World Première]. {Digital Master}

Producer: Roger Dean.

Sound Engineer and Sound Diffusion: Greg White.

Digital Editing: Adrian Luca, the University of Western Sydney (Nepean), Kingswood, Sydney, 22.12.1999.

Duration: 9'.55"

COMPACT DISC TOTAL TIME: 63'.43"

COMPACT DISC 2

*** TRACK 1: Lines of Light: Seven Improvisations on *αιθερος μελος* (1991/1993), for amplified recorders (1 player), two Yamaha DX7 keyboard synthesizers (1 or 2 players), and metallic percussion instruments (1 or 2 players).**

Ian Shanahan – amplified recorders; Roger Dean – two Yamaha DX7 keyboard synthesizers; Daryl Pratt – percussion.

Recorded at the ABC Studios (Studio 227), Ultimo, Sydney, 1.9.1994. {Digital Master}

Producer: Susan Shineberg.

Sound Engineer: Neale Sandbach.

Digital Editing: Adrian Luca, the University of Western Sydney (Nepean), Kingswood, Sydney, 22.12.1999.

Duration: 11'.06"

TRACK 2: Lines of Light: Seven Improvisations on *αιθερος μελος* (1991/1993), for amplified recorders (1 player), two Yamaha DX7 keyboard synthesizers (1 or 2 players), and metallic percussion instruments (1 or 2 players).

Ian Shanahan – amplified recorders; Roger Dean – two Yamaha DX7 keyboard synthesizers; Daryl Pratt and Richard Gleeson – percussion.

Recorded live, by the ABC, during a concert given by the ensemble *austraLYSIS* as part of the Tenth Sydney Spring International Festival of New Music, at The Studio, the Sydney Opera House, Sydney, 2.9.1999. {Digital Master}

Producer: Ralph Lane.

Sound Engineer: Dennis Fox.

Digital Editing and Denoising: Adrian Luca, the University of Western Sydney (Nepean), Kingswood, Sydney, 21.12.1999.

Duration: 10'.05"

*** TRACK 3: Arc of Light (1993), for solo piano.**

Simon Docking – piano.

Recorded at Ron Craig Studios, Colo Vale, NSW, 15.8.1994. {Digital Master}

Producer: Ian Shanahan.

Sound Engineer: Ron Craig.

Duration: 4'.12"

TRACK 4: Arc of Light (1993), for solo piano.

Roger Dean – piano.

Recorded live during a concert given by the ensemble *austraLYSIS*, at the Joseph Post Auditorium, the Sydney Conservatorium of Music, Sydney, 21.10.1995. {Digital Master}

Producer: Roger Dean.

Sound Engineer: Greg White.

Digital Denoising: Adrian Luca, the University of Western Sydney (Nepean), Kingswood, Sydney, 22.12.1999.

Duration: 3'.50"

TRACK 5: 153 Infinities (1996), for solo (amplified) piano and optional percussion (6 players).

Tamara Anna Cislowska – piano; the *Sprung Percussion Ensemble* (Guy du Blêt, Claire Edwardes, Richard Gleeson, Kevin Man, Luke McAvenna, Timothy Paillas).

Recorded live, by the ABC, during the Eighth Sydney Spring International Festival of New Music, at Eugene Goossens Hall, the ABC Centre, Ultimo, Sydney, 12.9.1997 [World Première]. {Digital Master}

Producer: Phil Carrick.

Sound Engineer: Dennis Fox.

Digital Editing: Adrian Luca, the University of Western Sydney (Nepean), Kingswood, Sydney, 4.9.1998.

Digital Denoising: Julian Knowles, the University of Western Sydney (Nepean), Kingswood, Sydney, 30.9.1998.

Duration: 11'.58"

TRACK 6: Zodiac: Crystal Orbit Improvisations (1996), a mandalikon for amplified soprano recorder, MIDI wind instrument, keyboard synthesizer, and optional real-time interactive computer control.

Ian Shanahan – amplified soprano recorder; Sandy Evans – Yamaha WX11 MIDI wind instrument (controlling a Yamaha DX7 [Series I] keyboard synthesizer); Roger Dean – Yamaha DX7 keyboard synthesizer; MAX software.

Recorded live during a concert given by the ensemble *austraLYSIS*, at The Performance Space, Redfern, Sydney, 20.7.1996 [World Première]. {Digital Master}

Producer: Roger Dean.

Sound Engineer and Sound Diffusion: Greg White.

Computer Interactivity (MAX patch): Roger Dean.

Digital Editing and Denoising: Adrian Luca, the University of Western Sydney (Nepean), Kingswood, Sydney, 22.12.1999.

Duration: 12'.32"

*** TRACK 7: Zodiac: Crystal Orbit Improvisations (1996), a mandalikon for amplified soprano recorder, MIDI wind instrument, keyboard synthesizer, and optional real-time interactive computer control.**

Ian Shanahan – amplified soprano recorder; Sandy Evans – Yamaha WX11 MIDI wind instrument (controlling a Yamaha DX7 [Series I] keyboard synthesizer); Roger Dean – Yamaha DX7 [Series I] keyboard synthesizer; MAX software.

Recorded by the ABC during a live national broadcast given by the ensemble *austraLYSIS* on ABC Classic FM, as part of the weekly radio programme "New Music Australia" (hosted by John Crawford), from Eugene Goossens Hall, the ABC Centre, Ultimo, Sydney, 23.9.1998. {Digital Master}

Producer: Phil Carrick.

Sound Engineer: Dennis Fox.

Sound Diffusion: Greg White.

Computer Interactivity (MAX patch): Roger Dean.

Duration: 8'.48"

COMPACT DISC TOTAL TIME: 63'.12"

COMPACT DISC 3

TRACK 1: Zodiac: Crystal Orbit Improvisations (1996), a mandalikon for amplified soprano recorder, MIDI wind instrument, keyboard synthesizer, and optional real-time interactive computer control.

Ian Shanahan – amplified soprano recorder; Sandy Evans – Yamaha WX11 MIDI wind instrument (controlling a Yamaha DX7 [Series I] keyboard synthesizer); Roger Dean – Yamaha DX7 keyboard synthesizer; MAX software.

Recorded live, by the ABC, during a concert given by the ensemble *austraLYSIS* as part of the Tenth Sydney Spring International Festival of New Music, at The Studio, the Sydney Opera House, Sydney, 2.9.1999. {Digital Master}

Producer: Ralph Lane.

Sound Engineer: Dennis Fox.

Computer Interactivity (MAX patch): Roger Dean.

Digital Editing and Denoising: Adrian Luca, the University of Western Sydney (Nepean), Kingswood, Sydney, 21.12.1999.

Duration: 12'.28"

TRACK 2: [p]s(t)ellor/mnême (1997), a mandalikon for soprano recorder and a broken consort of early-music instruments.

Ian Shanahan – soprano recorder; *The Renaissance Players* (Nick Wales – alto rebec and waterphone; Eleanor Lewis – bass viola da gamba; Cathy Tabrett – bass viola da gamba; Jenny Ericksson – bass viola da gamba; Kim Poole – mandola; Winsome Evans – Celtic harp; Andrew Lambkin – handbells; Sally Treloyn – handbells; Barbara Stackpool – handbell; Tim Chung – finger cymbals and timekeeper; Simon Lobelson – small clash cymbals).

Recorded and broadcast live, by the ABC, during a concert given by *The Renaissance Players* – to celebrate the group's thirtieth anniversary – as part of the Eighth Sydney Spring International Festival of New Music, at Eugene Goossens Hall, the ABC Centre, Ultimo, Sydney, 19.9.1997 [World Première, with live national broadcast on ABC Classic FM]. {Digital Master}

Producer: Ralph Lane.

Sound Engineer: Dennis Fox.

Digital Editing and Denoising: Julian Knowles, the University of Western Sydney (Nepean), Kingswood, Sydney, 30.9.1998.

Duration: 7'.35"

*** TRACK 3: Dimensiones Paradisi** (1991/1998), for solo alto flute.

Kathleen Gallagher – alto flute.

Recorded live, by the ABC, during the Ninth Sydney Spring International Festival of New Music, at Eugene Goossens Hall, the ABC Centre, Ultimo, Sydney, 26.9.1998 [World Première]. {Digital Master}

Producer: Owen Chambers.

Sound Engineer: Dennis Fox.

Digital Editing: Alex Cockburn, the University of Western Sydney (Nepean), Kingswood, Sydney, 8.10.1998.

Duration: 11'.40"

TRACK 4: Dimensiones Paradisi (1991/1998), for solo alto flute.

Kathleen Gallagher – alto flute.

Recorded live, by the ABC (ABC Classic FM), during the Tenth Australian Flute Convention (First Australian Flute Composition Competition), at the Main Theatre, the Queensland Conservatorium of Music, South Bank, Brisbane, 1.4.1999. {Digital Master}

Producer: Hans May.

Sound Engineers: Gary Yule and Peter McMurray.

Digital Editing: Adrian Luca, the University of Western Sydney (Nepean), Kingswood, Sydney, 16.4.1999.

Duration: 13'.16"

TRACK 5: Dimensiones Paradisi (1991/1998), for solo alto flute.

Kathleen Gallagher – alto flute.

Recorded live, by the ABC, during a concert given by the ensemble *austraLYSIS* as part of the Tenth Sydney Spring International Festival of New Music, at The Studio, the Sydney Opera House, Sydney, 2.9.1999. {Digital Master}

Producer: Ralph Lane.

Sound Engineer: Dennis Fox.

Digital Editing and Denoising: Adrian Luca, the University of Western Sydney (Nepean), Kingswood, Sydney, 21.12.1999.

Duration: 11'.21"

TRACK 6: A Brief Free Improvisation by members of *austraLYSIS* (2.9.1999), for amplified bass recorder, soprano saxophone, Yamaha DX7 keyboard synthesizer, and percussion.

Ian Shanahan – amplified bass recorder; Sandy Evans – soprano saxophone; Roger Dean – Yamaha DX7 [Series II] keyboard synthesizer; Daryl Pratt – percussion (marimba, bongos, 2 congas, large bass drum).

Recorded live, by the ABC, during a concert given by the ensemble *austraLYSIS* as part of the Tenth Sydney Spring International Festival of New Music, at The Studio, the Sydney Opera House, Sydney, 2.9.1999. {Digital Master}

Producer: Ralph Lane.

Sound Engineer: Dennis Fox.

Digital Editing and Denoising: Adrian Luca, the University of Western Sydney (Nepean), Kingswood, Sydney, 21.12.1999.

Duration: 4'.32"

COMPACT DISC TOTAL TIME: 61'.27"

COMPACT DISCS 1 – 3

PRODUCER: IAN SHANAHAN.

SOUND ENGINEER, DIGITAL EDITING, AND DIGITAL MASTERING: ADRIAN LUCA.

Produced at the Main Studio, Music Department, School of Contemporary Arts, the University of Western Sydney (Nepean), Kingswood, Sydney, 22.12.1999.

APPENDICES

APPENDIX 1: *MANIFESTO*

- from **Sound Ideas: Australian Composers born since 1950 – A Guide to their Music and Ideas** (ed. Brenton Broadstock), Australian Music Centre, Sydney, Australia, March 1995, pp.325–327.

Western society in the 1990s is racked by conflict, avarice, bureaucracy, divisive tribalism, stupidity, pettiness, politics, dualistic models, the folly of materialism, ignorance, mediocrity, the ethics of self-interest, illiteracy, fundamentalism in religion, decay and despair, gender war, corruption, cruelty, disease, ecological disaster, an alienation from nature, indifference, irresponsibility ... and a relentless sociocultural fragmentation that will soon reach the 'atomic level' of the individual. Our decadent civilization is, it seems, beginning its terminal meltdown (at last). Though one must go on...

We live in a crazy world. To compose is my way of trying to make sense of things, to acquire meaning and purpose; composition – and the infinite extension of its artistic possibilities – is my mantra.

Yet I would prefer not to be simplistically pigeon-holed as a 'composer' (let alone 'young Australian composer'): in my case, such a standpoint is far too restrictively specialized. To the contrary, and on the basis of my many diverse activities impinging upon the acoustic domain, I do regard myself more generally as a *scientist* who happens to work with the physical milieu of sound in order to construct a private cosmology. In many ways, therefore, I am philosophically and practically aligned to those marvellous interdisciplinary creators of the Middle Ages who subscribed to the *quadrivium* of *musica*, *astrologia* (astronomy), *geometria* and *arithmetica*, each one facet of a higher *unity*. Mine is a Vedic and Platonic ideal of music, that music-making be a vehicle for 'higher purpose', beyond the superficiality and transitoriness of 'culture': my work is concerned with the mystical and sacramental; integrity; 'being'; pattern and structure; intelligence; abstractness, number and proportion; interconnectivity; archetype, deepest meaning, and ... *unity*. I intend to keep building for myself a dynamic, living ontology founded upon this principle of unity, in which *Weltanschauung*, Artwork and personal action are all in accord as much as possible.

The German philosopher and contemporary music commentator Theodor Adorno is reputed to have remarked aphoristically:

Art that is experiment will live.
Art that is security will die.

Ostensibly, it might seem to be quite at odds with the previous lofty statements, but I am in complete, absolute agreement with this epigram.

Yet there *is* a deeper tangible connection. Since I seek a new ‘harmonious unity’, how can I be satisfied with regurgitating secure, established, second-hand musical syntaxes? Part of this endless theosophical search involves forging one’s *own* creative path, untainted by duality, and this entails continual ‘experiment’. Not a self-seeking, self-serving experimentalism, but one that is pregnant with vision, spirit, meaning, sincerity, expressivity, giving, and integrity: aspiring to create Art that is genuine; Art that will continue to reach out, to challenge, to move, to uplift, and to bind us together; Art that will change your reality; Art that is, and (hopefully) will remain, thoroughly *alive*.

Music, envisaged in its speculative part, is, as the Ancients defined it, the knowledge of the order of all things and the science of the harmonic relationships of the Universe; it rests on immutable principles which nothing can impair.

– Antoine Fabre d’Olivet (1767–1825)

I have always felt the power of music, that it is somehow elemental to nature and the Cosmos. So in aiming to compose a true *musica humana* which is at the same time very much a ‘music of Nature’ (*musica mundana*), I invoke the Laws of the Cosmos – as codified by Science. Paradigms from Mathematics, Astrophysics, Quantum Mechanics or Chaos Theory may inhabit my music, at every architectonic level; but most importantly, they should naturally permeate the music’s sound-world for listeners, so that my composition perceptually becomes a metaphorical mirror filled with intricate structural networks that could perhaps be interpreted as an (admittedly gross) simplification, essence, sign, or symbol of the infinite hierarchical nature of the Cosmos. In this regard, then, all of my music is a religious celebration, a desire to share and unite, an invocation, a response in awe (Pascal: “The Eternal Silence of Infinite Space terrifies me”). It is also *complex*. But how much more complex is our everyday reality, our mind(s), and the *unity* of the Cosmos itself? (James Joyce beautifully encapsulated this verity through his neologism “Chaosmos”.)

Example: Within its conceptual dimension, my composition **Cycles of Vega** is galvanized by a unique long-range quasi-cyclic astronomical process (‘precession’). It therefore utilizes extended and complex multilevel cyclic transformations within the timbral, temporal and frequency domains; these operations are scientifically encrypted in the Theory of Permutation Groups. The instrumentation – bringing to bear 18 windchimes in particular – physically exemplifies Chaos Theory through an inherently stochastic acoustical behaviour. Macroscopically, this work’s sound-world evokes an extremely

unearthly, timeless, cosmic, astral state: intended to proclaim our Universe's grandeur, I trust that **Cycles of Vega** is not just some lifeless 'acoustical orrery', but is, rather, a truly vibrant model of the Cosmos it extols.

My ongoing pursuit of unity, and of insight into music's mysterious origins and secrets, has resulted in a complete immersion over the last five years in various puissant arcana: the *esoteric* side of Mathematics (Sacred Geometry, *gematria*); acoustical symbolism; Hermetic Philosophy; the Holographic Paradigm; Gnosticism; Mythology; the (Neo)Platonists and Pythagoreans; ancient Science and Astronomy; theories of tuning and temperament, scales and harmonics... Works (as yet unfinished) which have been touched by these disciplines include **Dimensiones Paradisi** and **Gate of Remembrance**. Within more recent pieces – like my trio **Lines of Light** and its companion **Arc of Light** – I have even sought to relinquish total control over the work's surface minutiae ... while nevertheless retaining compositional responsibility for all deeper architecture and teleology. Such a stripping of notational detail and rigidity seems to have caused no great harm either to me or to my work, but has instead bestowed a welcome aura of freedom and spontaneity; this is one avenue I do mean to explore in the future.

As a practitioner of music in many of its aspects, I discern a grand continuum between all – a unity. For me, each aspect informs the others. Focussing here specifically upon performance and composition, my detailed and far-reaching researches into the acoustical capabilities of the recorder (and their realization in performance), provide a natural creative basis for considering the full range of technical resources of every instrument for which I compose. It would be unduly presumptuous of me, however, to evaluate my contribution to (Australian) music in the compositional field: it is not my place to do so. I sincerely hope, nonetheless, to leave behind a significant body of living Art, which will be judged favourably by history. I would like to be remembered as a truly committed artist who made a real contribution in many areas. (Maybe my documentation and promotion of the recorder and its potentialities has already left a legacy in that, as a direct outcome of my instigation through the commissioning process, several excellent Australian recorder compositions now exist...)

APPENDIX 2: *THE VIEW FROM MY LABORATORY, APRIL 1995*

- “The view from my laboratory, April 1995” [unabridged version], **Sounds Australian: Journal of Australian Music** No.46 Winter 1995, pp.25–26.

As a heretic in a decadent ‘civilization’ that is plummeting headlong towards an infinitely fractured, adversarial, nonliterate bureaucratic cesspool-like Dark Age, I aspire to the creation of a profound music supersaturated with true originality, colour, richness, maximal intelligence – ‘mind’ – and *unity*: a spiritual/transcendental music; a mystical music; a *musica humana* that also pours forth the *unified* patterns of nature, the universe, and beyond.

“True” originality?: one mediated through *gnosis*.

{I emphatically assert that this currently anathematized notion is alive and well; originality is dead only for those for whom it is dead (e.g. advocates of the emperor’s-new-clothes line that a rehash of ‘old’ is somehow ‘new’). Puissant composerly ‘R & D’ ever endures ...}

Example: Because of my ongoing love affair with Hermetism, pure mathematics and (meta)physics (etc.), I have become obsessed with unique permutational sacred-proportionalized holographic structures and with new musical schemata that extend beyond the corporeal manifestation of the artwork itself: diversity embraced in *unity* – *rapprochement* and interreferentiality in deep conceptual abstraction, beyond superficial, fictitious dualisms.

{Some will label me a ‘complexist’. OK ... if they really must. But I’m definitely not a bland, trendy, lobotomized ‘post-modernist’. ‘Post-modernism’ – aesthetically oxymoronic, and therefore chimerical – is just an academe-centred grab for power whose lexicon is no less obfuscatory than any it seeks to supplant. And the canons are still firing precisely because some of them are now stigmatized. Post-modernism’s espousal of plurality is a lie. In the field of ‘contemporary’ music, post-modernism has become, predominantly, a façade appropriated by ‘Neo-Capitulationists’ through which exudes intolerant reactionariness, wallowing in its own impotent uncreativity: dull, necrophilic, *pre-modern*, a euphemism for theft, an excuse to murder true artistic vision (for those who would prefer to see it eradicated), a cowardly retreat out of the millennium, ... a badge of musical maggothood.}

Ah! – audiences. I refuse to arrogate to myself the deluded, condescending, smug desire ‘to give “the” audience what “they” want’ (as if some monolithic ‘Otherhood’ with ‘ubiquitous taste’ exists, and one could genuinely *discern* it ... not that such a common dilettantish vanity matters in the slightest, anyhow). For it remains a most efficacious *fait accompli* that art of quality and substance mysteriously generates *its own* sustained public demand, however small.

{Community appreciation of art is never reducible to a simplistic 'numbers game': slavish head-counting belongs in the dungeons of nescient (pseudo)populism and of atmospheroccephalous bureaucracy.}

In any case, our audiences nowadays are almost always to be found listening, in private, to music projected through loudspeakers. And one cannot honestly know who or how many hit the *OFF* button (let alone what music provokes such a response). Alas, it is increasingly the concert halls and opera houses – *passé* contexts? – that are, *per se*, élitist: ticket prices for live events often exclude the poor; CDs don't. (I'm CD-friendly.)

{So the populist bums-on-seats arguments, dogmatized to discredit the musically adventurous, no longer cut it. Integrity and exploration, however, do.}

Anyway, my various musical activities – together with the composing of chess problems and an enthusiastic absorption of arcana – help me to make sense of, and find purpose in, a world gone mad; these pursuits serve to keep me sane (although some might question whether such endeavours have actually succeeded in this).

{*PS.* I also greatly enjoy listening to the musics of: Delius, Jennifer Fowler, Chick Corea, Tibetan lamas and other Buddhists (*shōmyō*), ...}

APPENDIX 3: EXCERPTS FROM A RESEARCH PAPER ON IAN SHANAHAN'S *CYCLES OF VEGA*

- All passages below are quotations from Catherine A. Beaumont: **Ian Shanahan: A Glimpse into his World-View and Music through An Analysis of *Cycles of Vega***, BMus(Hons) Research Paper, Department of Music, The University of Sydney, November 1993.

Shanahan's primary research interests include advanced 'philosophical', 'theosophical' and 'scientific' studies. Such pursuits are at the core of Shanahan's compositions. In his **Manifesto** (1990), he regards himself as a "scientist who happens to work with the physical milieu of sound".¹ Shanahan claims, as a composer, not to be concerned with geographical, historical or political influences. He is inspired, rather, by concepts of the whole Universe and its links with science, music and theology, as unified in the 'sacred triangle',² [about] which Shanahan states [that] he is an "ardent devotee of each apex". Shanahan's compositions are, therefore, a reflection of his perception and experience of the Universe, his *Weltanschauung*. Through them, he hopes to "forge a personal living musical cosmology". In simpler terms, Shanahan has said to me:

We live in a crazy world. To compose ... is my way of trying to make sense of things, to acquire meaning and purpose.³

Shanahan states: "I believe science to be the study and explication of the Physical Laws of [the] Cosmos". Shanahan takes scientific paradigms found particularly in nature, astronomy and cosmology (i.e. the science of the nature, origin and history of the Universe), and tries to invoke them in his own music. Astronomy, in particular, has proven to be a predominant source of inspiration in several of Shanahan's major works, including **Solar Dust: Orbits and Spirals** (1988/1999), **Arcturus Timespace** (1987/1994), and **Cycles of Vega** (1988–1991). ... In **Cycles of Vega**, Shanahan combined his astronomical and musical interests to choose Vega (α Lyrae), the brightest star in the musically named constellation Lyra, as the metaphorical centrepiece of the composition. ...

Notes

1. Ian Shanahan: **Manifesto** (October 1990), p.1. [**Manifesto** – reproduced as Appendix 1, above – was published in **Sound Ideas: Australian Composers born since 1950 – A Guide to their Music and Ideas** (ed. Brenton Broadstock), Australian Music Centre, Sydney, March 1995, pp.325–327.] This claim is related to Shanahan's deep interest in science and mathematics. He combines such pursuits with music in his compositions. Such interrelations are emphasized by the fact that as a student at The University of Sydney, he took a double major in Music and Pure Mathematics.
2. The 'sacred triangle' is a concept derived from the *quadrivium* of the Middle Ages, wherein scholars of this period studied *musica* (music), *astrologia* (astronomy), *geometria* (geometry), and *arithmetica* (arithmetic). Shanahan's 'sacred triangle' embraces *musica*, *scientia* (knowledge, or science), and *theologia* (theology). He feels that *scientia* and *theologia*, taken together, subsume the *quadrivium's* disciplines of *astrologia*, *geometria* and *arithmetica*.
3. Ian Shanahan (Interview, September 1993).

– Beaumont (1993), p.3.

Silence is also an important element in **Cycles of Vega** – and [within] all of Shanahan's music in general. The use of silence was partly inspired by Blaise Pascal:

Le silence éternel des espaces infinis m'effraie.

The use of silences – periods of inactivity, perhaps leaving only a residue of

resonances – is particularly striking in **Arcturus Timespace**, and the composer quotes Pascal in his programme notes ... The music [of] **Arcturus Timespace** is accompanied by “slide projections [which] consist of various stars, star systems, nebulae, galaxies, gas clouds and sheets ...”. The long silences in the piece allow the audience time to contemplate the images before them.

In **Cycles of Vega**, the sounds seem to emerge from, and fade away into, silence. Shanahan says he uses both sounds and silence as “meditative tools”,¹ for periods of silence or inactivity give his music ‘space’, thus allowing the audience to contemplate the sounds they hear.

Returning to the concept of the ‘sacred triangle’, we see that **Cycles of Vega** contains numerous examples of the way Shanahan combines his interests in science and music. Finally, he also makes reference to the Creator, stating, about the sound-world of **Cycles of Vega**, that “I try to evoke ... an extremely unearthly, timeless, cosmic, astral state: the work is intended to celebrate the grandeur of God’s Universe”.²

Notes

1. Ian Shanahan (Interview, June 1993).
2. **Cycles of Vega**, Programme Annotation [the earliest version].

Astral state: the term ‘astral’ has a double meaning. In the context of Shanahan’s statement, both meanings are intended by the composer: (a) of, or connected with, the stars; (b) Theosophy relating to, or arising from, a supposed ethereal existence. ...

– Beaumont (1993), p.5.

Shanahan has been consistent in exploring the latent possibilities of the instruments for which he composes. This is evident from [his] sketches ... Shanahan states:

I prefer to be limited by choice, rather than through ignorance of what sonic resources I have available.¹

Notes

1. Ian Shanahan (Interview, September 1993).

– Beaumont (1993), p.20.

Shanahan views the act of composing, performing or listening to music as a ‘ritual’ experience. He sees music as a sacrament in itself, whereby it connects the visible, corporeal, tangible world to something beyond – something invisible, transcendental and untouchable:

Men may see or feel in all things something more than the things themselves. So the sacramental comes into existence.

A sacrament, our catechism said, is ‘an outward and visible sign of an inward and spiritual grace.’ The outward and visible attributes, which can never be the whole of existence or the whole of experience, are balanced and completed by attributes ‘inward and spiritual.’ Between them is the connecting link of a sign, something seen, touched, handled, eaten, painted, sung, danced, or spoken. The sign, like the arrow on the weather vane, points to something beyond itself and invisible.¹

In discussing his own role as a composer, Shanahan enthusiastically cites the following statement:

The role of the composer and performer is obvious ...: they are the alchemists who help to transmute the Earth by making its substance and souls resonate with echoes of the heavenly music. In so doing, these earthly echoes also [become] audible in Heaven, and the gulf between the two thereby closes by another hairsbreadth. This is the accomplishment of the Great Work of musical alchemy which, like alchemy proper, aims towards the redemption of all Nature as well as to the reunion of Man with his Overself.²

Irrespective of how obvious (or obscure) the above statement may be to his audience, Shanahan takes this metaphysical role – the ‘binding of Heaven to Earth’ via music – very seriously. Through his music, he aspires to bring both the earthly and [the] cosmic realms together, with humanity in between. He hopes to provide an experience which puts people into a state of contemplation whereby they will ponder universal concepts and philosophies and then, after the piece is over, remain moved to keep some of their ruminations with them in their everyday life.

A message he wishes to convey is one of humility, emerging from the Hermetic Philosophy, wherein human beings are seen to be microcosms of the whole – the macrocosm. In his own words:

We ought to be humble, and look beyond our immediate local situations to see that we are part of something far bigger: we belong ... in a much wider sense; we, whose very atoms were born in the hearts of stars, are children of the Universe, and more ... this I find very comforting ... an act of grace.³

Characteristic of much of Shanahan’s music is the sense of what [the Australian critic] Peter McCallum has called “galactic awe”, as well as cavernous silences which allow for such contemplations. He intends his music to pose absolute questions, not dispense absolute answers.

In combination with his extended compositional techniques, Shanahan’s music is rendered ‘complex’⁴ through his multi-levelled invocations of scientific and mathematical paradigms of nature and the Universe: his music demonstrates both acoustical *and* mental polyphonies. Through its complexity, Shanahan hopes that he creates “music that is absolutely ‘relevant’ because it aspires to replicate the complexity of the Cosmos (as we know it), and so touches us with its palpable realism”.

Shanahan has indicated during interviews that for any performance of his music, an informed, open-minded and receptive audience is desirable. This is emphasized by his often lengthy and detailed programme annotations, which include information on the philosophical, theo[logic]al and scientific concepts upon which a piece is founded, in addition to commentary on musical aspects such as its instrumentation and form.

It is still possible, however, to engage with Ian Shanahan’s music without being informed of all of [its] musical and philosophical nuances. The sound-world of Shanahan’s music has a unique attraction of its own, ... it provides a foreground to the work which is easily accessible to the listener – and may invite some to ‘scratch beneath the surface’. The more detailed or esoteric levels behind this foreground may not be immediately apprehensible, but they are integral to the *raison d’être* and aesthetic essence of the piece, and do impart at least a subliminal awareness of the work’s depth and its sense of ‘mind’. Nevertheless, with an obvious hint from [his pieces’] title[s], it is possible for a keen musical ear to hear – to consciously register – the cyclic structures within [a composition of his such as] **Cycles of Vega** without prior study of the work. ... With regard to his audience, and their response to his music, Shanahan has the following to say:

Are not both the *qualitative* aspects of an audience’s response and the *quantity* of

people reached conceptually equivalent in value? Surely engaging and deeply affecting a solitary human being through exposure to a work of Art is as great a cause for celebration by the Artist as the mass entertainment or amusement of a larger public body? Won't as many people be touched ultimately by the transcending "Arrows of Time and Space" which allow a difficult Artwork's message to emanate outwards geographically and reach Humanity far into the future, well beyond the isolated and frozen instants of a single restricted, more commercially-oriented or fashionable artistic event that impinges upon only a large, but fixed, group of people at a particular place?⁵

Notes

1. Trapp (1975), p.81.
2. Godwin (Vermont, U.S.A., 1987), p.81.
3. Ian Shanahan (Interview, September 1993).
4. Toop (1988), p.4: "The term 'complex' in the context of this paper refers to the 'relative difficulty of technical execution and density of musical substance'".
5. ed. Ian Shanahan and Chris Dench: "An Emotional Geography of Australian Composition", **Sounds Australian: Journal of Australian Music** No.34, Winter 1992, p.31.

– Beaumont (1993), pp.56–58.

... It is ... difficult to situate [Ian Shanahan] amongst composers of today. There is, however, clearly an element of 'complexity' in his music (and so a connection with the [music] of the 'New Complexity'), stemming primarily from his application of mathematical concepts.

Mathematical models are also an area of interest for the [English-born] Australian composer Chris Dench (b.1953), whom Shanahan sees as being 'on a similar wavelength'. He also points out that Dench has had a positive critical influence upon his work. Shanahan explains how he had begun to falter by using instrumental techniques purely as acoustical effects, and rather indiscriminately, to mould the surface of his music; Dench brought this to Shanahan's attention, who has since tried to avoid writing music which relies excessively upon surface gestures rather than musical depth.¹ The [Sydney-based] critic Peter McCallum also associates elements of Shanahan's compositional style with that of Chris Dench, explaining that both use music to express very individual esoteric and scientific concepts. As a result, the methods and ideas they apply to their musics do tend to stretch the listener "outside the normal response mechanism".² McCallum believes both Dench and Shanahan to be two very individual composers.

It has already been pointed out that Shanahan does wish to appeal to an informed, open-minded audience, and that some of his music, by virtue of its sensuous nature, does indeed have an instant appeal. Nevertheless, immediate audience response, understanding, and assimilability are not central to Shanahan's aesthetic. In fact, an intrinsic part of Shanahan's compositional persona is his unrelenting reaction against any compromise through seeking 'easy' audience acceptance and commercial 'marketability', especially through the use of what he sees to be second-hand, retrospective musical syntaxes. The question of 'accessibility' has in fact been pivotal among the issues Shanahan has raised in his writings and polemics in journals such as **Sounds Australian**, which have often raised controversy. Until recently actively involved in the politics of music, Shanahan has been a committee member of the [Australian] branch of the *International Society for Contemporary Music* (1983–1993) and President of the *Fellowship of Australian Composers* (1988–1992), and has no fear of standing up for his own beliefs. The Australian composer Moya Henderson

has commented briefly on his commitment, saying that he is much admired for the role he takes upon himself, and that many are grateful for his efforts. Nevertheless, she fears that he may have made some enemies.³

In summary, the following can be said of [Ian] Shanahan's approach to music and compositional style:

Shanahan's interests in philosophy, theology, science, mathematics and cosmology are a central influence upon his musical style. He consciously tries to imbue his music with these pursuits at every level. Such a conceptual approach to musical composition stems from his personal view that science, music and theology are closely interlinked, as represented by his metaphor of the 'sacred triangle'. The emphasis Shanahan places upon this 'sacred' relationship manifests itself in several ways: he often uses scientific and mathematical paradigms as a foundation for his compositions. In **Cycles of Vega**, this is achieved through its hierarchic cyclical structures (which reflect astronomical, natural, and biological cycles), and its reliance upon a panoply of windchimes (whose mechanics exemplify Chaos Theory). Through such methods, Shanahan aims to create "a music which is not just a lifeless 'acoustical orrery', but a metaphorical mirror, a truly vibrant model, of the Cosmos".

His music also affirms his belief in the primacy of the time-domain, as reflected by its spaciousness, its resonance, and the duration of its sounds and silences. These elements are engaged as 'meditative tools', through which the listener is invited to contemplate the universal archetypes that inspired his music. Shanahan views the creation and experiencing of music as a sacramental act, through which the listener can transcend beyond 'mundane time', into the realm of 'sacred time', bringing the earthly and cosmic realms closer together.

Another of Shanahan's key concerns is the extension of sonic possibilities in the world of music, where he ardently promotes the notion of 'sounds unlimited'. Through his compositions, he experiments with new sonic devices and explores ... extended techniques on traditional instruments. These open up a colourful new universe of timbres, which Shanahan clearly explores in his compositions, contributing to their unique sound-worlds.

Shanahan's compositional techniques [sometimes] depose pitch as music's fundamental organizational element: the fabric of his music relies more upon the pre-eminence of time and time-relations. The innovations of Olivier Messiaen have clearly encouraged Shanahan to move in such a direction, as evidenced particularly [by] Shanahan's **Echoes/Fantasies** and **Cycles of Vega**, where the system of permutations used is [in certain respects] parallel to those of Messiaen's **Chronochromie**.

While **Cycles of Vega** has legitimate claims to being a unique piece – taking steps forward both in its compositional techniques and its sonorities – it nevertheless exists in an historical continuum. Techniques employed by Shanahan reach back to fourteenth-century isorhythm, and more recently (during this century) to Messiaen's rhythmic organization and the new sound-worlds of experimental composers such as Varèse and Cage.

Whilst many are instantly attracted to the appealing sonorities of Ian Shanahan's music, it is definitely music which repays repeated listening. As one gains more insight into the background and intricate structural subtleties of his music, one finds more and more facets to appreciate. But the recency of Shanahan's work ... implies that there is, as yet, little [long-term] audience response available. As with all new music, it is impossible to arrive at any definitive value judgements [concerning]

Shanahan's work. Like all artistic endeavours throughout history, only 'time will tell' how well Shanahan's music [shall be] revered.

Notes

1. Ian Shanahan (Interview, 2.11.1993).
2. Peter McCallum (Interview, 2.11.1993).
3. Moya Henderson (Interview, 3.11.1993).

– Beaumont (1993), pp.59–60.

APPENDIX 4: A BRIEF BIOGRAPHICAL NOTE

Ian Shanahan (born 13/6/1962 at Camperdown, NSW, Australia) is a composer, performer (recorders, trombone), improviser and educator. Ian enrolled in 1980 for the BMus degree at the University of Sydney, completing a double major in music and pure mathematics; he graduated in 1986 with first-class honours and the University Medal. Ian's composition teachers were Eric Gross, Peter Sculthorpe and Ian Fredericks (for computer music). Now under the supervision of Anne Boyd, he is currently enrolled in a PhD degree (in composition) at the same institution, where he is also a part-time lecturer in orchestration, composition and twentieth-century harmony. In February 1996, Ian Shanahan was appointed lecturer in performance and composition in the Music Department of the School of Contemporary Arts at the University of Western Sydney (Nepean).

From 1988 to 1992, Ian Shanahan was President of the *Fellowship of Australian Composers* (Australia's national composers' organization [FAC]) and Secretary-Treasurer of the Australian Branch of the *International Society for Contemporary Music* [ISCM]. In 1986, and again in 1990, Ian was the Australian delegate to the annual *Asian Composers' League* Conference/Festival. He was also a member of the editorial panel of the FAC's official journal, **Ossia**; a CD which he co-produced, **Ossia (Volume 1)**, was released in 1992.

Ian's compositions – most of which are now commercially available on CD under the *Evasound*, *Broad Music* and *Move* labels – have received several awards and numerous performances both locally and internationally, to widespread acclaim. For instance, his recent work **[p]s(t)ellor/mnême** won the inaugural *Sydney Spring International Festival of New Music Composition Award* (1997). Ian was one of only two Australians selected to be a Composer Fellow at the inaugural *Pacific Music Festival* (Sapporo, Japan, 1990).

In addition to his compositional activities, Ian has been active as a self-taught recorder-player and promoter of new music for this instrument. He has commissioned composers (both within Australia and overseas) to write for him, and has given many performances, workshops, and recordings of their works – as well as lecturing, broadcasting, and writing widely about the rich possibilities of the recorder. Solo performances have been given by Ian under the auspices of the 1988 *Blue Mountains Festival*, the *New Music Conference* (Brisbane, 1990), the 1994, 1996 and 1997 *Sydney Improvisation Festivals*, and *New Music Forum* (Melbourne, 1995); he has also appeared with renowned new music ensembles such as *austraLYSIS*, *Symeron* and *ELISION*. During 1987, Ian was invited as a

guest composer/performer to the *Asian Composers' Forum* in Sendai, Japan, where he gave a lecture-recital dealing primarily with 'extended techniques' for the recorder. In 1988, he was part of the Australian contingent – the only musician – that travelled to Bologna, Italy to celebrate the ninth centenary of Bologna University. At both of these events, he gave highly lauded concerts of contemporary Australian recorder music.

Although he specializes in post-1960 recorder music and research into new instrumental capabilities, Ian enjoys regular forays into vernacular, classical, and early musics: he has been a member of *Van Diemen's Bush Band*, *Plectra*, and *The Renaissance Players*. Ian also played trombone with the Sydney University Orchestra for ten years, and now occasionally 'blows his horn' with a rock band at St Paul's Anglican Church, Castle Hill, NSW; he was a founding chorister (bass) with *The Contemporary Singers* during the mid to late '80s.

Ian has recorded and produced several radio programmes that explore diverse aspects of new music; he has also written a number of scholarly articles for various publications and has guest co-edited **Sounds Australian Journal** twice. Outside of music, Ian has a great passion for chess problems – he is a Fellow of the *British Chess Problem Society* – and numerous other intellectual pursuits.

APPENDIX 5: LIST OF COMPOSITIONS BY IAN SHANAHAN

The following compositions by Ian Shanahan are all published either by the Australian Music Centre (in facsimile), or by some other professional Australian publishing house – except for those marked with an asterisk (*):

1. **Piece for Chamber Orchestra** (1980), for chamber orchestra.
Duration: ca.3'. Private performance at the University of Sydney. * *WITHDRAWN*
2. **Fanfare for Caissa** (1980), for 3 trumpets.
Duration: ca.4'. Performed by students of the Royal College of Music, London; conducted by Sir David Willcocks, at the Royal Albert Hall, London, May 1981.
3. **SineBirds : Feral Abacus** (1981), for 'tape'.
Duration: 2'.37".
4. **Legends** (1981), for solo flute.
Duration: ca.9'. Performed by Joannes Roose, at the Seventh Australian Flute Convention, Adelaide, 2 April 1988.
5. **Entr'acte** (1981), for 6 percussionists.
Duration: ca.2'. Unperformed. * *WITHDRAWN*
6. **Pastels** (1982), for solo clarinet in A.
Duration: ca.5'. Performed by Lawrence Dobell during a *Seymour Group* concert, at the University of Sydney, 28 April 1983 [World Première].
7. **Cortège** (1982), for alto trombone, 2 tenor trombones, bass trombone, 7 percussionists, harp, and piano.
Duration: ca.4'. Unperformed. * *WITHDRAWN*
8. **Cosmos** (1982), for solo piano.
Duration: ca.3'. Unperformed! * *WITHDRAWN*
9. **Echoes** (1983), for orchestra.
Duration: ca.8'. Performed by the *ABC National Training Orchestra*, conducted by Wilfred Lehmann, May 1983 [World Première]; and again by the *Queensland Symphony Orchestra*, conducted by David Kram, February 1984. * *WITHDRAWN*
10. **Echoes/Fantasies** (1984), for bass clarinet and percussion (vibraphone(s) and tubular bells).
Duration: ca.7'.30". Commissioned by the *Seymour Group*. Performed by Nigel Westlake (bass clarinet) and Michael Askill (vibraphone, tubular bells) during an ISCM concert, at the Recording Hall, Sydney Opera House, 16 June 1985.
11. **Lament** (1985), for solo tenor voice.
Duration: ca.2'. Performed by Philip Chu during the C21 New Music Festival, at The Old Darlington School, the University of Sydney, 16 August 2001 [World Première].

12. Music for the documentary film **God Doesn't Play Dice** (1985). *

13. Music for the documentary film **Mysteries of the Mind** (1986). *

14. **Arcturus Timespace** (1987/1994), for soloist (amplified mandolin and percussion) and 'tape', with optional light- and image-projection.
 Duration: ca.12'. Commissioned by *ELISION* ensemble. Performed by Stephen Morey during an *ELISION* Concert, at Melba Hall, the University of Melbourne, 6 May 1987.

15. **Solar Dust: Orbits and Spirals** (1988/1999), for solo (amplified) mandolin.
 Duration: ca.10'. Commissioned by Adrian Hooper and *The Sydney Mandolins*. Performed by Paul Hooper, at the Netherlands Uniting Church, Quarry Street, Ultimo, Sydney, 9 September 1988 [World Première].

16. **Cathy's Song** (1988), an encore piece for solo sopranino (or alto) recorder.
 Duration: ca.1'. Published in "Recorders at Large, Volume Two" (ed. Benjamin Thorn), Currency Press, Sydney, 1995. Performed by Ian Shanahan during "Recorders Unlimited", a concert held at The Old Darlington School, the University of Sydney, 8 December 1989.

17. **Cycles of Vega** (1988–1991), for e \flat clarinet and 2 percussionists.
 Duration: ca.10'. Commissioned by Roslyn Dunlop. Performed by Roslyn Dunlop (e \flat clarinet), Daryl Pratt and Anthony Cowdroy (percussion), during the Second Sydney Spring International Festival of New Music, at the Sydney Art Gallery, 2 November 1991 [World Première].

18. **Gahu** (1989), for 'tape' or 8 percussion/Orff Schulwerk (for young musicians).
 Duration: ca.10'. Unperformed. * *WITHDRAWN*

19. **Helical Ribbon** (1990), a terse étude for solo alto recorder.
 Duration: ca.0'.40". Published in "Recorders at Large, Volume Two" (ed. Benjamin Thorn), Currency Press, Sydney, 1995. Commissioned by the Australian Music Centre. Performed by Ian Shanahan during a Sounds Australian Awards Presentation Night, at the Sydney Dance Company Space, Sydney, 11 April 1990 [World Première].

20. **Dysfunctional Habañera** (1990), for solo alto recorder.
 Duration: ca.0'.30". To be published by Red House Editions? Commissioned by Benjamin Thorn. Unperformed in public!

21. **Graeme Petrie, scallywag** (1990), for solo alto recorder.
 Duration: ca.0'.45". To be published by Red House Editions? Commissioned by Benjamin Thorn. Unperformed in public!

22. **Lingua Silens Florum** (1991), a garland for solo prepared alto recorder.
 Duration: ca.0'.50". Published by Red House Editions No. RH 938, Melbourne, 1995. Performed by Ian Shanahan during the Eric Gross Farewell Concert, at the Everest Theatre, the University of Sydney, 8 August 1991 [World Première].

23. **Ritual Canons** (1982/1993), for 3 tenor trombones and bass trombone.
 Duration: ca.4'. Unperformed!

24. **αιθερος μελος – Microcosm** (1991/1993), for e \flat clarinet, percussion and contrabass.
 Duration: ca.1'.15". Commissioned by *austraLYSIS*. Preliminary version performed by Peter Jenkin (e \flat clarinet), Daryl Pratt (percussion) and Roger Dean (contrabass), at the Joseph Post Auditorium, Sydney Conservatorium of Music, 9 July 1991. * *WITHDRAWN*

25. **Lines of Light: Seven Improvisations on αιθερος μελος** (1991/1993), for amplified recorders (1 player), two Yamaha DX7 keyboard synthesizers (1 or 2 players), and metallic percussion instruments (1 or 2 players).
Duration: ca.9'.30". Commissioned by *austraLYSIS*. Performed by Ian Shanahan (amplified recorders), Roger Dean (two Yamaha DX7 keyboard synthesizers) and Daryl Pratt (percussion), during an *austraLYSIS* concert ("Redesigning the System"), at the Joseph Post Auditorium, Sydney Conservatorium of Music, 27 November 1993 [World Première].
26. **Arc of Light** (1993), for solo piano.
Duration ca.2'.15"—4'. Published by Grevillea Editions (The Yitpi Series [ISBN 1–876266–54–6]), Maybole via Ben Lomond NSW, September 1997. Commissioned by Robert Allworth. Performed by Simon Docking, at The Old Darlington School, the University of Sydney, 14 August 1994 [World Première].
27. **153 Infinities** (1996), for solo (amplified) piano and optional percussion (6 players).
Duration ca.11'. Commissioned by Roger Woodward and the Sydney Spring International Festival of New Music. Performed by Tamara Anna Cislowska (piano) and the *Sprung Percussion Ensemble* (Guy du Blêt, Claire Edwardes, Richard Gleeson, Kevin Man, Luke McAvenna, Timothy Paillas) during the Eighth Sydney Spring International Festival of New Music, at Eugene Goossens Hall, ABC Centre, Harris Street, Ultimo, Sydney, 12 September 1997 [World Première].
28. **Zodiac: Crystal Orbit Improvisations** (1996), a mandalikon for amplified soprano recorder, MIDI wind instrument, keyboard synthesizer, and optional real-time interactive computer control.
Duration: variable. Commissioned by *austraLYSIS*. Performed by Ian Shanahan (amplified soprano recorder), Sandy Evans (Yamaha WX11 MIDI wind instrument), Roger Dean (Yamaha DX7 keyboard synthesizer) and MAX software, during an *austraLYSIS* concert, at The Performance Space, 199 Cleveland Street, Redfern, Sydney, 20 July 1996 [World Première].
29. **[p]s(t)ellor/mnême** (1997), a mandalikon for soprano recorder and a broken consort of early-music instruments.
Duration ca.8'–10'. Commissioned by Winsome Evans and *The Renaissance Players* (for *The Renaissance Players'* thirtieth anniversary). Performed by Ian Shanahan (soprano recorder) and *The Renaissance Players* (Nick Wales [alto rebec and waterphone], Eleanor Lewis [bass viola da gamba], Cathy Tabrett [bass viola da gamba], Jenny Ericksson [bass viola da gamba], Kim Poole [mandola], Winsome Evans [Celtic harp], Andrew Lambkin [handbells], Sally Treloyn [handbells], Barbara Stackpool [handbell], Tim Chung [finger cymbals and timekeeper] and Simon Lobelson [small clash cymbals]) during the Eighth Sydney Spring International Festival of New Music, at Eugene Goossens Hall, ABC Centre, Harris Street, Ultimo, Sydney, 19 September 1997 [World Première, with live national broadcast].
30. **Cosmos (One Note)** (1987/1997), for solo Yamaha DX7 keyboard synthesizer.
Duration: ca.6'. Performed by Ian Shanahan, at The Performance Space, Music Department, the University of Western Sydney (Nepean), Kingswood Campus, 13 November 1997 [World Première].
31. **Dimensiones Paradisi** (1991/1998), for solo alto flute.
Duration ca.9'. Commissioned by Laura Chislett. Performed by Kathleen Gallagher during the Ninth Sydney Spring International Festival of New Music, at Eugene Goossens Hall, ABC Centre, Harris Street, Ultimo, Sydney, 26 September 1998 [World Première].
{A facsimile of the manuscript of an earlier version of **Dimensiones Paradisi**, for solo piccolo, was published in **Context** No.2, Summer 1991, pp.38–43.}
32. **Harmonia {in PP}** (2001), for tenor recorder and piano.
Duration: ca.4'.45"—5'.50". Performed by Ian Shanahan (tenor recorder) and Diana Blom (piano) during the Peter Platt Memorial and Dedication Concert, at The Old Darlington School, the University of Sydney, 15 August 2001 [World Première].
33. **Gate of Remembrance: 12 Hypostases** (1993–), for solo (amplified) piano.
Duration ca.23'. Commissioned by Roger Woodward. To be premièred by Roger Woodward.

APPENDIX 6: DISCOGRAPHY

Note: In addition to the publication of Compact Disc [CD] recordings of Ian Shanahan's compositions, this Discography includes all commercial CD releases of performances by Ian Shanahan of other composers' works.

1. CD: "Music from St Michael's, Vaucluse, Sydney and St Andrew's Cathedral, Sydney", Evasound Records Jade JADCD-1012. Released in Australia, April 1990.

Robert Allworth: **How Many Sunsets Will I See?**

Ian Shanahan (alto recorder) and Paul Hooper (mandolin)

2. CD: "Earth Spirit", Evasound Records Jade JADCD-1013. Released in Australia, August 1990.

Ian Shanahan: **Solar Dust: Orbits and Spirals**

Paul Hooper (mandolin)

Ian Shanahan: **Echoes/Fantasies**

Nigel Westlake (bass clarinet) and Michael Askill (vibraphone, tubular bells)

3. CD: "Times Remembered", Evasound Records Jade JADCD-1022. Released in Australia, June 1991.

Ian Shanahan: **Cathy's Song**

Ian Shanahan (sopranino recorder)

Ian Shanahan: **Helical Ribbon**

Ian Shanahan (alto recorder)

4. CD: "Ossia (Volume 1)", Evasound Records Jade JADCD-1024. Released in Australia, April 1992.

Ian Shanahan: **Arcturus Timespace**

Stephen Morey (mandolin, percussion)

5. CD: "Splendour of the Past", Evasound Records Jade JADCD-1025. Released in Australia, April 1992.

Ian Shanahan: **Lingua Silens Florum**

Ian Shanahan (prepared alto recorder)

6. CD: "River Songs", Evasound Records Jade JADCD-1026. Released in Australia, June 1992.

Robert Allworth: **2 Bagatelles**

Ian Shanahan (soprano recorder)

7. CD: "Where no Shadows Fall", Evasound Records Jade JADCD-1031. Released in Australia, November 1992.

Peter Sculthorpe: **A Sun Song for Eric**

Ian Shanahan (alto recorder), Dominique Guerbois (violin), and Susan Blake ('cello)

8. CD: "Concerto", Evasound Records Jade JADCD-1038. Released in Australia, May 1993.

Robert Allworth: **2 Bagatelles**

Ian Shanahan (soprano recorder)

9. CD: "Music for a Champagne Breakfast", Evasound Records Jade JADCD-1040. Released in Australia, August 1993.

Ian Shanahan: **Pastels**
Roslyn Dunlop (clarinet in A)

10. CD: "Barely Spring", Broad Music Records Jade JADCD-1045. Released in Australia, March 1994.

Robert Allworth: **Meditation of Saint Clare**
Ian Shanahan (tenor recorder)

11. CD: "Music for a Festive Occasion", Broad Music Records Jade JADCD-1048. Released in Australia, April 1994.

Ian Shanahan: **Cycles of Vega**
Roslyn Dunlop (e♭ clarinet), Daryl Pratt and Anthony Cowdroy (percussion)

12. CD: "Arc of Light", Broad Music Records Jade JADCD-1050. Released in Australia, November 1994.

Ian Shanahan: **Arc of Light**
Simon Docking (piano)

Ian Shanahan: **Cathy's Song**
Ian Shanahan (sopranino recorder)

Ian Shanahan: **Lingua Silens Florum**
Ian Shanahan (prepared alto recorder)

Ian Shanahan: **Helical Ribbon**
Ian Shanahan (alto recorder)

Elliott Gyger: **Strands II – Miniature Variations**
Ian Shanahan (bass recorder), Jane Lewis (flute, piccolo), Ingrid Pearson (clarinet), Dominique Guerbois (violin), Susan Blake ('cello), Winsome Evans (harpsichord), and Simon Docking (piano)

13. CD: "Skinless Kiss of Angels", ABC Classics ABC446625-2. Released in Australia and internationally through ABC Classics and Polygram, May 1995.

Michael Smetanin: **Spin Ø**
Ian Shanahan (amplified bass recorder) and Stephanie McCallum (amplified harpsichord)

14. CD: "Phoenix Songs", Move Records MOVE MD3165. Released in Australia through Move Records, June 1995.

Ian Shanahan: **Cathy's Song**
Genevieve Lacey (sopranino recorder)

Ian Shanahan: **Lingua Silens Florum**
Genevieve Lacey (prepared alto recorder)

Ian Shanahan: **Helical Ribbon**
Genevieve Lacey (alto recorder)

15. CD: "Artisans of Australia", Broad Music Records Jade JADCD-1054. Released in Australia, July 1995.

Ian Shanahan: **Cathy's Song**
Ian Shanahan (sopranino recorder)

Ian Shanahan: **Helical Ribbon**
Ian Shanahan (alto recorder)

16. CD: "The Listening Room: Delta", ABC Music 4797612. Released in Australia and internationally through ABC Classics and Polygram, July 1995.

Jonathan Mills: **Four Songs**

Ian Shanahan (recorders), Geoffrey Collins (flute), Nigel Westlake (bass clarinet), James Blunt (trumpet), Graeme Leak (percussion), Catherine Hewgill ('cello), Jacqui Rutten and Jonathan Mills (voices)

17. CD: "Best of Australian Classics", Broad Music Records Jade JADCD-1065. Released in Australia, November 1996.

Bruce Cale: **Cullenbenbong**

Ian Shanahan (bass recorder, 7 Japanese temple bells [rin])

18. CD: "Australian Fanfare", Broad Music Records Jade JADCD-1070. Released in Australia, July 1997.

Ian Shanahan: **Solar Dust: Orbits and Spirals**

Paul Hooper (mandolin)

Ian Shanahan: **Echoes/Fantasies**

Nigel Westlake (bass clarinet) and Michael Askill (vibraphone, tubular bells)

19. Enhanced CD: "Great is Your Love: Songs from St Paul's Castle Hill", Yes! Ministries YMCD001. Released in Australia, November 1997.

Chris Griffiths: **Lifted Me Up (Psalm 40) †**

Nicole Schleicher: **Awesome and Great †**

Chris Timperley: **Jesus is Alive †**

Trevor Hodge: **Not Worthy †**

Trevor Hodge: **Psalm 100 †**

† All songs: Ian Shanahan (trombone), Michael Petrusis (trumpet), Elizabeth Corey (alto saxophone), Anthony Bock (tenor saxophone), Dionne Bock (flute, piccolo), Murray Blythe (guitars), Trevor Hodge (bass guitar, vocals), Ben Drew (piano, vocals), David Sheerman (keyboard synthesizer), Tim Jarrett (drums), David Atkins (percussion), Skye Watson (violin), Jennie Cooper and Tim Willson ('celli), Diana Blythe, Chris Griffiths, Peter Langshaw, Nicole Schleicher, Catherine Beaumont and Jennifer Herbert (vocals)

20. CD: "Australian Music for Film: Remembering Adrian Braun", Broad Music Records Jade JADCD-1073. Released in Australia, November 1997.

Ian Shanahan: **Arc of Light**

Simon Docking (piano)

21. CD: "Solar Dust", Broad Music Records Jade JADCD-1080. Released in Australia, November 1998.

Ian Shanahan: **Arcturus Timespace**

Stephen Morey (mandolin, percussion)

Ian Shanahan: **Solar Dust: Orbits and Spirals**

Paul Hooper (mandolin)

Ian Shanahan: **153 Infinities**

Tamara Anna Cisłowska (piano) and the *Sprung Percussion Ensemble* (percussion sextet)

Gary Monger: **Gecko**

Ian Shanahan (soprano recorder)

22. CD: “The Original – Music for a Champagne Breakfast” [New Digital Master], Broad Music Records Jade JADCD–1085. Released in Australia, July 1999.

Ian Shanahan: **Pastels**
Roslyn Dunlop (clarinet in A)

23. CD: “Fray”, Broad Music Records Jade JADCD–1086. Released in Australia, July 1999.

Ian Shanahan: **Helical Ribbon**
Ian Shanahan (alto recorder)

Ian Shanahan: **Lingua Silens Florum**
Ian Shanahan (prepared alto recorder)

Ian Shanahan: **Cathy’s Song**
Ian Shanahan (sopranino recorder)

Ian Shanahan: **Dysfunctional Habañera**
Ian Shanahan (alto recorder)

Ian Shanahan: **Graeme Petrie, scallywag**
Ian Shanahan (alto recorder)

24. CD: “Shoalhaven Suite”, Broad Music Records Jade JADCD–1087. Released in Australia, December 1999.

Ian Shanahan: **Cycles of Vega**
Roslyn Dunlop (e♭ clarinet), Daryl Pratt and Anthony Cowdroy (percussion)

25. CD: “Echoes/Fantasies”, Broad Music Records Jade JADCD–1088. Released in Australia, March 2000.

Ian Shanahan: **Echoes/Fantasies**
Nigel Westlake (bass clarinet) and Michael Askill (vibraphone, tubular bells)

Ian Shanahan: **SineBirds : Feral Abacus**
for ‘tape’

Ian Shanahan: **Helical Ribbon**
Ian Shanahan (alto recorder)

Ian Shanahan: **Lingua Silens Florum**
Ian Shanahan (prepared alto recorder)

Ian Shanahan: **Cathy’s Song**
Ian Shanahan (sopranino recorder)

Ian Shanahan: **Dysfunctional Habañera**
Ian Shanahan (alto recorder)

Ian Shanahan: **Graeme Petrie, scallywag**
Ian Shanahan (alto recorder)

26. CD: “The Sinking of the Rainbow Warrior”, Vox Australis VAST028–2. Released in Australia by the Australian Music Centre, August 2000.

Colin Bright: **The Sinking of the Rainbow Warrior**
Ian Shanahan (sopranino, soprano, alto, tenor and bass recorders), Margery Smith (clarinet, bass clarinet), Daryl Pratt (percussion), Roger Dean and Stephanie McCallum (keyboard synthesizers), Elizabeth Jones (violin), Maxim Bibeau (bass guitar, contrabass), Ruth Kilpatrick and Nicole Thomson (sopranos), Jo Burton (alto), Paul McMahon (tenor), Mark Donnelly (baritone), and Clive Birch (bass)

27. CD: "Hammock Blues", Jude Handel Records JH001. Released in Australia, August 2000.

Jude Handel: **Hammock Blues**

Ian Shanahan (soprano, tenor and bass recorders), Ian Pritchett (sitar), and Jude Handel (vocals, piano)

28. CD: "Dulcie Holland and Friends", Broad Music Records Jade JADCD-1089. Released in Australia, October 2000.

Ian Shanahan: **Dysfunctional Habañera**

Ian Shanahan (alto recorder)

29. CD: "American Dream", Broad Music Records Jade JADCD-1090. Released in Australia, February 2001.

Ian Shanahan: **Solar Dust: Orbits and Spirals**

Michael Hooper (mandolin)

30. CD: "Lines of Light", Broad Music Records Jade JADCD-1091. Released in Australia, August 2001.

Ian Shanahan: **Lines of Light: Seven Improvisations on αιθερος μελος**

Ian Shanahan (amplified recorders), Roger Dean (two Yamaha DX7 keyboard synthesizers), and Daryl Pratt (percussion)

Ian Shanahan: **Arc of Light**

Roger Dean (piano)

31. CD: "Auburn Splendour", Broad Music Records Jade JADCD-1092. Released in Australia, December 2001.

Ian Shanahan: **Harmonia {in PP}**

Ian Shanahan (tenor recorder) and Andrew Robbie (piano)

Ian Shanahan: **Zodiac: Crystal Orbit Improvisations**

Ian Shanahan (amplified soprano recorder), Sandy Evans (Yamaha WX11 MIDI wind instrument controlling a Yamaha DX7 Series I keyboard synthesizer), Roger Dean (Yamaha DX7 Series II keyboard synthesizer), and MAX software

32. CD: "There came a wind like a bugle: chamber music by Nigel Butterley", Tall Poppies Records TP142. Released in Australia and internationally, December 2001.

Nigel Butterley: **The White-Throated Warbler**

Ian Shanahan (sopranino recorder) and Diana Blom (harpsichord)

APPENDIX 7: LIST OF WRITINGS BY IAN SHANAHAN

A. Journal Articles, Lecture Papers, Reports, Letters, and Unpublished Material

1. "An Analysis of **Echoes/Fantasies** (1984) for bass clarinet, vibraphone(s) and tubular bells", Unpublished Analytical Writing, Sydney, Australia, October 1985.
2. "31-Note Music by Bill Coates: Fingerings for Alto Recorder", Unpublished Information Sheet, Sydney, Australia, February 1986.
3. "A Basic Circe Variant: Strict Circe", **The Problemist** Vol.12 No.10, July 1986, p.194.
4. "Recorder Unlimited: An Introduction with special consideration of Multiple Sonorities": lecture paper delivered to the **Sydney Branch of The Musicological Society of Australia**, The University of Sydney, 2 August 1986.
5. "Recent Australian Music": Australian Country Report, delivered to **The 11th Asian Composers' League Conference**, Taipei, Taiwan, October 1986.
6. "*ELISION* ... The Cutting Edge of Sound", **The Australian Composer: Newsletter of the Fellowship of Australian Composers** August 1987, p.3.
7. "The Eleventh *Asian Composers' League* Conference/Festival", **The Australian Composer: Newsletter of the Fellowship of Australian Composers** August 1987, pp.4–5.
8. Conference Paper: Seminar C (Contemporary Recorder Techniques), **Asian Composers' Forum** in Sendai, Japan, 19 September 1987.
9. "Sounds Unlimited", **1988 Blue Mountains Festival Performing Notes**, The *Blue Mountains Festival* Ltd., Darlinghurst NSW, Australia, 1988, pp.12–15.
10. "Success Stories", **The Australian Composer: Newsletter of the Fellowship of Australian Composers** December 1988, p.7.
11. "Recent Travels", **The Australian Composer: Newsletter of the Fellowship of Australian Composers** December 1988, pp.7–8.
12. "The Theory of Bitones", **Ossia** No.1, Winter 1989, pp.17–23.
13. Letter to the Editor captioned: "APC Headache (No.2)", **Sounds Australian: Journal of Australian Music** No.23, Spring 1989, pp.1–2.
14. Brief [heavily edited] analyses of compositions by Eric Gross (**3 Klavierstücke**) and Peter Tahourdin (**Quartet for Strings**) in the Handbook accompanying the **Anthology of Australian Music on Disc**, Canberra School of Music, December 1989.
15. "Australian Music During 1989": Australian Country Report, delivered to **The 13th Asian Composers' League Conference/Festival**, Tokyo/Sendai, Japan, March 1990.
16. "Manifesto", Unpublished Writing, Sydney, Australia, October 1990. ["Manifesto" – reproduced as Appendix 1, above – was later published in **Sound Ideas: Australian Composers born since 1950 – A Guide to their Music and Ideas** (ed. Brenton Broadstock), Australian Music Centre, Sydney, Australia, March 1995, pp.325–327.]
17. "Audibility and Inaudibility in Twentieth-Century Music: **Arcturus Timespace** (1987), by Ian Shanahan", Unpublished Writing, Sydney, Australia, November 1990.
18. "Ideal Circe Serieshelpstalemates with KBS versus K", **Ideal-Mate Review** No.40, April–June 1991, p.15.

19. "Blueprint for a Piece: Ian Shanahan's Sure-Fire Recipe for Music comprised of Fractal Sounds generated by a Prepared Alto Recorder", Unpublished Information Sheet, Sydney, Australia, 22 May 1991.
20. "Multicultural Influences on Australian Composition", in **The Composer Speaks: Composers and Their Colleagues Discuss Australian Music** (ed. Graeme Skinner), Sounds Australian, Sydney, Australia, June 1991, pp.32–35.
21. "Recorders Now and Then" [Concert Review], **The Recorder: Journal of the Victorian Recorder Guild** No.13, June 1991, pp.23–24.
22. Letter to the Editor captioned: "When is Humour Humorous?", **Sounds Australian: Journal of Australian Music** No.31, Spring 1991, p.3.
23. "The Malaise of (not just) Australian Music", **Context** No.2, Summer 1991, pp.34–37.
24. Letter to the Editor captioned: "Not the Thought Police", **Sounds Australian: Journal of Australian Music** No.32, Summer 1991, p.2.
25. "The *Asian Composers' League*, and Related Issues", **Sounds Australian Update** December 1991 – January 1992, pp.11–12.
26. "Eric Gross: A Profile of the Composer", in **Contemporary Composers** (ed. P. Collins and B. Morton), St James Press, London, 1992, pp.350–351.
27. (ed., with Chris Dench): "An Emotional Geography of Australian Composition", **Sounds Australian: Journal of Australian Music** No.34, Winter 1992, pp.8–32.
28. Letter to the Editor captioned: "More acoustical goulash", **Sounds Australian Update** September 1992, p.3.
29. Letter to the Editor captioned: "Invocation: Live and Let Live!", **Sounds Australian Update** November 1992, pp.3–4.
30. "Some Random Thoughts on John Cage (1912–1992), and 'New' Music", Unpublished Paper, Sydney, Australia, 21 December 1992: delivered as a Radio Lecture/Performance as part of **A Tribute to John Cage: Returning the Compliment**, ABC-FM Stereo, 21 December 1992.
31. "A Hierarchical Metalogue on Accessibility, Innovation and Parasitism", Unpublished Writing, Sydney, Australia, October 1993–.
32. Letter to the Editor captioned: "X in Xmas", **The Sydney Morning Herald** 28 December 1993, p.12.
33. "Welcome to McMusic Corporation", Unpublished Writing, Sydney, Australia, January 1994.
34. Letter to the Editor captioned: "Is lack of thought a virtue?", **Sounds Australian: Journal of Australian Music** No.41, Autumn 1994, pp.2–3.
35. Foreword to **One Hundred Chess Compositions** (by Peter Wong), Privately Published, Sydney, Australia, July 1994, p.6.
36. "A Footnote to 'Turning an Anderssen into an Indian'", **The Problemist Supplement** No.16, January 1995, p.126.
37. "Ian Shanahan", in **Sound Ideas: Australian Composers born since 1950 – A Guide to their Music and Ideas** (ed. Brenton Broadstock), Australian Music Centre, Sydney, Australia, March 1995, pp.209–212 & pp.325–327.

38. "The view from my laboratory, April 1995", **Sounds Australian: Journal of Australian Music** No.46, Winter 1995, pp.25–26.
39. (ed., with Chris Dench): "An Emotional Geography of Australian Composition II", **Sounds Australian: Journal of Australian Music** No.46, Winter 1995, pp.9–31.
40. "Chess Problem Corner (Part 1)", **Junior Chess: The Quarterly Magazine of the NSW Junior Chess League** No.65–66, September 1995, pp.69–71.
41. Foreword to **200 Chess Problems** (by Arthur Willmott), Privately Published, Adelaide, Australia, November 1995, pp.3–4.
42. "Chess Problem Corner (Part 2)", **Junior Chess: The Quarterly Magazine of the NSW Junior Chess League** No.67, November/December 1995, pp.93–95.
43. Foreword to **100 Pawnless Chess Problems** (by Arthur Willmott), Privately Published, Adelaide, Australia, February 1996, pp.3–4.
44. "Chess Problem Corner (Part 3)", **Junior Chess: The Quarterly Magazine of the NSW Junior Chess League** No.68, February/March 1996, pp.68–69.
45. "Chess Problem Corner (Part 4)", **Junior Chess: The Quarterly Magazine of the NSW Junior Chess League** No.69, May/June 1996, pp.56–59.
46. "Extended Instrumental Techniques (for Woodwinds)": lecture paper delivered during the colloquium **Australian Chamber Music (1970–)**, The University of Western Sydney (Nepean), 21 February 1997.
47. "Music Notation in the Late Twentieth Century", Unpublished Lecture, Sydney, Australia, March 1997.
48. "Improvisation in Renaissance Music", Unpublished Lecture Notes, Sydney, Australia, April 1997.
49. "Competition No.1 – Concerning Harmonicity", Unpublished Writing, Sydney, Australia, May 1997.
50. "An Undeclared Tribalism in 'Australian' Sonics", **Postwest** Vol.3 No.2, June 1997, pp.9–10.
51. "Total Fleck Theme in #2 Miniature", **The Problemist** Vol.16 No.4, July 1997, pp.170–171.
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53. "Authenticity: Some Points", Unpublished Lecture Notes, Sydney, Australia, July 1998.
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56. "Free Improvisation: Some Points", Unpublished Lecture Notes, Sydney, Australia, February 1999.
57. Letter to the Editor, **Sagacity Magazine** No.5 (1999), September 1999, p.13.
58. "On Music Research": lecture paper delivered during a Postgraduate Symposium, School of Contemporary Arts, The University of Western Sydney (Nepean), 12 October 1999.

59. Letter to the Editor, ***Australian Music Centre Update*** No.112, October–November 1999, p.11.
60. “Within a World of Becoming: Words and Instrumental Symbolism in the Music of Ian Shanahan”, Unpublished Essay, Sydney, Australia, February 2000.
61. “Professor Peter Platt, AM (1924–2000)” [Obituary], ***Australian Music Centre Update*** No.118, October–November 2000, pp.1–2; reprinted: ***The Consort: The Journal of the Dolmetsch Foundation*** Vol.56, Summer 2000, pp.62–63.
62. “Tries and their Refutations in the Two-Mover: A Solver’s Perspective”, ***The Problemist*** Vol.17 No.12, November 2000, pp.503–504.
63. “BCPS [British Chess Problem Society] Tourney Award: Fairies 1995”, ***The Problemist*** Vol.18 No.2, March 2001, pp.77–81.

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1. **The Avant-Garde Recorder: A Preliminary Study of some Recent Developments in Alto Recorder Playing Techniques, and their Notation**, BMus(Hons) Thesis, The University of Sydney, November 1985.
2. **Recorder Unlimited: A Preliminary Study of the Alto Recorder’s Multiphonic Resources**, PhD(Prelim.) Thesis, The University of Sydney, April 1993. {To be published by the University of California Press, Berkeley, California, U.S.A., in “The New Instrumentation” series.}

APPENDIX 8: LIST OF WRITINGS ABOUT IAN SHANAHAN

Apart from those bibliographic entries below marked with an asterisk (*), copies of all of the following writings can be obtained from:

THE AUSTRALIAN MUSIC CENTRE LTD

PO Box N690
Grosvenor Place
NSW 1220
Australia

Level 4, The Arts Exchange
18 Hickson Road
The Rocks, Sydney,
NSW, Australia

Telephone: +61 2 9247 4677; 1800 651 834

Fax: +61 2 9241 2873

E-mail: info@amcoz.com.au

World Wide Web: www.amcoz.com.au

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COVELL, ROGER: "A new slant on creating music for modern life" [Concert Review], **The Sydney Morning Herald** 29 November 1993, p.19.

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- COVELL, ROGER: "Extravaganza of sound and dance" [Concert Review], **The Sydney Morning Herald** 21 February 1994, p.19.
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- DENCH, CHRIS: "Metalogue", **Sounds Australian: Journal of Australian Music** No.29, Autumn 1991, pp.17–20.
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- MARAL, LOUISE: "In memoriam: music for and by a loved 'Prof'", **The University of Sydney News** Vol.33 No.12, 27 July 2001, p.7.
- MCCALLUM, PETER: "Ossia – Australian Composers (Volume 1)" [CD Review], **Sounds Australian: Journal of Australian Music** No.34, Winter 1992, pp.44–45.
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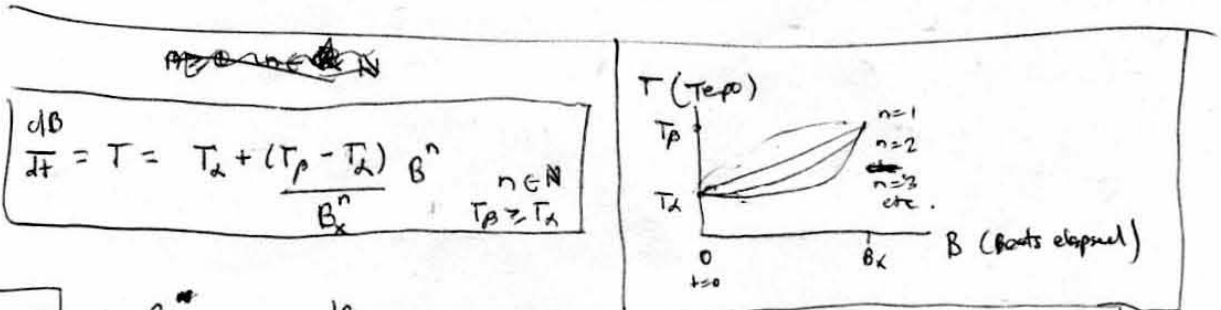
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APPENDIX 9: MANUSCRIPTS CONTAINING MATHEMATICAL FORMULAE FOR TEMPO-GLISSANDI

$$T = \sqrt{1 + 2\alpha B}$$



$n=1$: $\frac{B_x}{B_x T_A + (T_P - T_A) B} \frac{dB}{dt} = 1$

$$\frac{dB}{dt} = T = T_A + \frac{(T_P - T_A)}{B_x} B \quad T_P \geq T_A$$

$$\int \frac{B_x}{B_x T_A + (T_P - T_A) B} \frac{dB}{dt} dt = \int dt$$

$$\int \frac{B_x}{B_x T_A + (T_P - T_A) B} dB = \int dt$$

$$\frac{B_x}{(T_P - T_A)} \log [B_x T_A + (T_P - T_A) B] = t + C_0 \quad (*)$$

$$\log [B_x T_A + (T_P - T_A) B] = \frac{(T_P - T_A)}{B_x} t + C_1$$

$$B_x T_A + (T_P - T_A) B = C_2 \exp \left[\frac{(T_P - T_A)}{B_x} t \right] \quad t=0 \Rightarrow C_2 = B_x T_A \quad (B=0)$$

$$B_x T_A + (T_P - T_A) B = B_x T_A \exp \left[\frac{(T_P - T_A)}{B_x} t \right]$$

*
$$B = \frac{B_x T_A}{(T_P - T_A)} \left[\exp \left[\frac{(T_P - T_A)}{B_x} t \right] - 1 \right]$$

$\Rightarrow T = T_A \exp \left[\frac{(T_P - T_A)}{B_x} t \right]$

"Exponential accel." ($\eta_{\text{accel}} = \frac{dT}{dt} = \frac{T_A (T_P - T_A)}{B_x} \exp \left[\frac{(T_P - T_A)}{B_x} t \right] = \frac{(T_P - T_A)}{B_x} T$)

$$t = \frac{B_x}{(T_P - T_A)} \left[\log T - \log T_A \right] = \frac{B_x}{(T_P - T_A)} \log \left[1 + \frac{(T_P - T_A)}{B_x T_A} B \right]$$

$t = f(T) \qquad \qquad \qquad t = g(B)$

①

$$n=2 \quad \left[\frac{dB}{dt} = T = T_A + \frac{(T_P - T_A)}{B_x^2} B^2 \right] \quad T_P \geq T_A$$

$$\frac{B_x^2}{B_x^2 T_A + (T_P - T_A) B^2} \frac{dB}{dt} = 1$$

$$\int \frac{B_x^2}{B_x^2 T_A + (T_P - T_A) B^2} \frac{dB}{dt} dt = \int dt$$

$$\int \frac{B_x^2}{B_x^2 T_A + (T_P - T_A) B^2} dB = \int dt$$

$$\int \frac{dx}{a+bx^2} = \frac{1}{a} \int \frac{dx}{1+(\frac{b}{a}x)^2} \quad \text{Put } x = \sqrt{\frac{a}{b}} \tan \theta$$

$$(ab > 0) = \frac{1}{a} \int \frac{\sqrt{\frac{a}{b}} \sec^2 \theta d\theta}{\sec^2 \theta} \Rightarrow dx = \sqrt{\frac{a}{b}} \sec^2 \theta d\theta$$

$$= \frac{1}{\sqrt{ab}} \int d\theta \quad \theta = \tan^{-1} \left(\sqrt{\frac{b}{a}} x \right)$$

$$= \frac{1}{\sqrt{ab}} \theta$$

$$= \frac{1}{\sqrt{ab}} \tan^{-1} \left(\sqrt{\frac{b}{a}} x \right) \quad \text{---} \quad \text{---}$$

$$\frac{B_x^2}{B_x \sqrt{T_A(T_P - T_A)}} \tan^{-1} \left[\sqrt{\frac{(T_P - T_A)}{B_x^2 T_A}} B \right] = t + c_0 \quad \text{by } (*)$$

$$\frac{B_x}{\sqrt{T_A(T_P - T_A)}} \tan^{-1} \left(\frac{1}{B_x} \sqrt{\frac{T_P}{T_A} - 1} B \right) = t + c_0 \quad t=0 (B=0) \Rightarrow c_0=0$$

$$\frac{B_x}{\sqrt{T_A(T_P - T_A)}} \tan^{-1} \left(\frac{1}{B_x} \sqrt{\frac{T_P}{T_A} - 1} B \right) = t \quad (*)$$

$$\frac{1}{B_x} \sqrt{\frac{T_P}{T_A} - 1} B = \tan \left(\frac{\sqrt{T_A(T_P - T_A)}}{B_x} t \right)$$

$$* \quad B = B_x \sqrt{\frac{T_A}{(T_P - T_A)}} \tan \left(\frac{\sqrt{T_A(T_P - T_A)}}{B_x} t \right)$$

$$* \Rightarrow T = T_A \sec^2 \left(\frac{\sqrt{T_A(T_P - T_A)}}{B_x} t \right) \quad \text{"Trigonometric accel."} \quad \left(\frac{dT}{dt} = \frac{2T_A}{B_x} \sqrt{T_A(T_P - T_A)} \sec^2(\dots) \tan(\dots) \right)$$

$$= \frac{2}{B_x} \sqrt{T_A(T_P - T_A)} T \sqrt{\frac{T_P}{T_A} - 1}$$

$$* \Rightarrow t = \frac{B_x}{\sqrt{T_A(T_P - T_A)}} \cos^{-1} \sqrt{\frac{T_A}{T}} = \frac{B_x}{\sqrt{T_A(T_P - T_A)}} \tan^{-1} \left(\frac{1}{B_x} \sqrt{\frac{T_P}{T_A} - 1} B \right) \quad \text{by } (*)$$

$$t = f(T) \quad t = g(B)$$

(2)

$$n=3 \quad \frac{dB}{dt} = T = T_A + \frac{(T_P - T_A)}{B_X^3} B^3 \quad T_P \neq T_A$$

$$\frac{B_X^3}{B_X^3 T_A + (T_P - T_A) B^3} \frac{dB}{dt} = 1$$

$$\int \frac{B_X^3}{B_X^3 T_A + (T_P - T_A) B^3} \frac{dB}{dt} dt = \int dt$$

$$\int \frac{B_X^3}{B_X^3 T_A + (T_P - T_A) B^3} dB = \int dt$$

$$\frac{B_X^4 \left(\frac{T_A}{T_P - T_A} \right)^{\frac{1}{3}}}{6 B_X^3 T_A} \left\{ \log \left[\frac{[B + B_X \left(\frac{T_A}{T_P - T_A} \right)^{\frac{1}{3}}]^3}{B^3 + B_X^3 \left(\frac{T_A}{T_P - T_A} \right)} \right] + 2\sqrt{3} \tan^{-1} \left[\frac{1}{\sqrt{3}} \left(2 \left(\frac{B}{B_X} \right) \left(\frac{T_P}{T_A} - 1 \right)^{\frac{1}{3}} - 1 \right) \right] \right\}$$

$$\frac{B_X}{6 T_A} \left(\frac{T_A}{T_P - T_A} \right)^{\frac{1}{3}} \left\{ \log \left[\frac{[B + B_X \left(\frac{T_A}{T_P - T_A} \right)^{\frac{1}{3}}]^3}{B^3 + B_X^3 \left(\frac{T_A}{T_P - T_A} \right)} \right] + 2\sqrt{3} \tan^{-1} \left[\frac{1}{\sqrt{3}} \left[2 \left(\frac{B}{B_X} \right) \left(\frac{T_P}{T_A} - 1 \right)^{\frac{1}{3}} - 1 \right] \right] \right\} = t + C_0 \quad \text{by } (*)$$

$$t=0 \quad (B=0) \Rightarrow C_0 = \frac{B_X}{6 T_A} \left(\frac{T_A}{T_P - T_A} \right)^{\frac{1}{3}} \cdot 2\sqrt{3} \tan^{-1} \left(\frac{1}{\sqrt{3}} \right)$$

$$= \frac{B_X}{6 T_A} \left(\frac{T_A}{T_P - T_A} \right)^{\frac{1}{3}} \cdot \frac{-\pi}{\sqrt{3}}$$

$$t = \frac{B_X}{6 T_A} \left(\frac{T_A}{T_P - T_A} \right)^{\frac{1}{3}} \left\{ \log \left[\frac{[B + B_X \left(\frac{T_A}{T_P - T_A} \right)^{\frac{1}{3}}]^3}{B^3 + B_X^3 \left(\frac{T_A}{T_P - T_A} \right)} \right] + 2\sqrt{3} \tan^{-1} \left[\frac{1}{\sqrt{3}} \left[2 \left(\frac{B}{B_X} \right) \left(\frac{T_P}{T_A} - 1 \right)^{\frac{1}{3}} - 1 \right] \right] + \frac{\pi}{\sqrt{3}} \right\}$$

$$n=4 \quad \boxed{\frac{dB}{dT} = T = T_A + \frac{(T_P - T_A)}{B_x^4} B^4} \quad T_P \geq T_A$$

$$\frac{B_x^4}{B_x^4 T_A + (T_P - T_A) B^4} \frac{dB}{dT} = 1$$

$$\int \frac{B_x^4}{B_x^4 T_A + (T_P - T_A) B^4} dB = \int dt$$

$$\int \frac{B_x^4}{B_x^4 T_A + (T_P - T_A) B^4} dB = \int dt$$

$$\int \frac{B_x^4}{B_x^4 T_A + (T_P - T_A) B^4} dB = \int dt$$

$$\int \frac{dx}{a+bx^4} = \frac{\Theta}{4a\sqrt{2}} \left[\log \left(\frac{x^2 + \Theta\sqrt{2}x + \Theta^2}{x^2 - \Theta\sqrt{2}x + \Theta^2} \right) + 2 \tan^{-1} \left(\frac{\Theta\sqrt{2}x}{\Theta^2 - x^2} \right) \right]$$

(ab > 0) where $\Theta = \sqrt[4]{\frac{a}{b}}$ worked out by I.S. Gruntz in table of Integrals.

for $a = B_x^4 T_A$
 $b = (T_P - T_A) \quad \Theta = B_x \left(\frac{T_A}{T_P - T_A} \right)^{\frac{1}{4}} \quad (*)$

$$\frac{B_x^5}{4B_x^4 T_A \sqrt{2}} \left(\frac{T_A}{T_P - T_A} \right)^{\frac{1}{4}} \left[\log \left(\frac{B^2 + B B_x \sqrt{2} \left(\frac{T_A}{T_P - T_A} \right)^{\frac{1}{4}} + B_x^2 \sqrt{\frac{T_A}{T_P - T_A}}}{B^2 - B B_x \sqrt{2} \left(\frac{T_A}{T_P - T_A} \right)^{\frac{1}{4}} + B_x^2 \sqrt{\frac{T_A}{T_P - T_A}}} \right) + 2 \tan^{-1} \left(\frac{B B_x \sqrt{2} \left(\frac{T_A}{T_P - T_A} \right)^{\frac{1}{4}}}{B_x^2 \sqrt{\frac{T_A}{T_P - T_A}} - B^2} \right) \right]$$

$$\frac{B_x}{4T_A \sqrt{2}} \left(\frac{T_A}{T_P - T_A} \right)^{\frac{1}{4}} \left\{ \log \left[\frac{B^2 + B B_x \sqrt{2} \left(\frac{T_A}{T_P - T_A} \right)^{\frac{1}{4}} + B_x^2 \sqrt{\frac{T_A}{T_P - T_A}}}{B^2 - B B_x \sqrt{2} \left(\frac{T_A}{T_P - T_A} \right)^{\frac{1}{4}} + B_x^2 \sqrt{\frac{T_A}{T_P - T_A}}} \right] + 2 \tan^{-1} \left[\frac{B B_x \sqrt{2} \left(\frac{T_A}{T_P - T_A} \right)^{\frac{1}{4}}}{B_x^2 \sqrt{\frac{T_A}{T_P - T_A}} - B^2} \right] \right\} = t + c_0$$

$t=0 (B=0) \Rightarrow c_0 = 0$

$$t = \frac{B_x}{4T_A \sqrt{2}} \left(\frac{T_A}{T_P - T_A} \right)^{\frac{1}{4}} \left\{ \log \left[\frac{B^2 + B B_x \sqrt{2} \left(\frac{T_A}{T_P - T_A} \right)^{\frac{1}{4}} + B_x^2 \sqrt{\frac{T_A}{T_P - T_A}}}{B^2 - B B_x \sqrt{2} \left(\frac{T_A}{T_P - T_A} \right)^{\frac{1}{4}} + B_x^2 \sqrt{\frac{T_A}{T_P - T_A}}} \right] + 2 \tan^{-1} \left[\frac{B B_x \sqrt{2} \left(\frac{T_A}{T_P - T_A} \right)^{\frac{1}{4}}}{B_x^2 \sqrt{\frac{T_A}{T_P - T_A}} - B^2} \right] \right\}$$

NOTE To ensure the continuity of $t = f(B)$, for $B \geq \Theta = B_x \left(\frac{T_A}{T_P - T_A} \right)^{\frac{1}{4}}$ take the next branch of \tan^{-1} . i.e. for $B \geq B_x \left(\frac{T_A}{T_P - T_A} \right)^{\frac{1}{4}}$

$$t = \frac{B_x}{4T_A \sqrt{2}} \left(\frac{T_A}{T_P - T_A} \right)^{\frac{1}{4}} \left\{ \log \left[\frac{B^2 + B B_x \sqrt{2} \left(\frac{T_A}{T_P - T_A} \right)^{\frac{1}{4}} + B_x^2 \sqrt{\frac{T_A}{T_P - T_A}}}{B^2 - B B_x \sqrt{2} \left(\frac{T_A}{T_P - T_A} \right)^{\frac{1}{4}} + B_x^2 \sqrt{\frac{T_A}{T_P - T_A}}} \right] + 2 \tan^{-1} \left[\frac{B B_x \sqrt{2} \left(\frac{T_A}{T_P - T_A} \right)^{\frac{1}{4}}}{B_x^2 \sqrt{\frac{T_A}{T_P - T_A}} - B^2} \right] + 2\pi \right\}$$

where \tan^{-1} denotes the principal branch of \tan^{-1} .

(4)

$$\frac{dB}{dt} = T = T_A \cosh^n\left(\frac{B}{B_A}\right) + \left(\frac{T_P - T_A \cosh^n 1}{\sinh^n 1}\right) \sinh^n\left(\frac{B}{B_A}\right) \quad \begin{matrix} n \in \mathbb{N} \\ T_P \geq T_A \end{matrix}$$

$$n=1: \quad \frac{dB}{dt} = T = T_A \cosh\left(\frac{B}{B_A}\right) + \left(\frac{T_P - T_A \cosh 1}{\sinh 1}\right) \sinh\left(\frac{B}{B_A}\right) \\ = \left(\frac{e}{e^2 - 1}\right) \left[(T_P - \frac{1}{e} T_A) e^{\left(\frac{B}{B_A}\right)} - (T_P - e T_A) e^{-\left(\frac{B}{B_A}\right)} \right] \quad T_P \geq T_A$$

$$\frac{(e - \frac{1}{e})}{\left[(T_P - \frac{1}{e} T_A) e^{\left(\frac{B}{B_A}\right)} - (T_P - e T_A) e^{-\left(\frac{B}{B_A}\right)} \right]} \frac{dB}{dt} = 1 \\ \int \frac{(e - \frac{1}{e})}{\left[(T_P - \frac{1}{e} T_A) e^{\left(\frac{B}{B_A}\right)} - (T_P - e T_A) e^{-\left(\frac{B}{B_A}\right)} \right]} \frac{dB}{dt} dt = \int dt \\ \int \frac{(e - \frac{1}{e})}{(T_P - \frac{1}{e} T_A) e^{\left(\frac{B}{B_A}\right)} - (T_P - e T_A) e^{-\left(\frac{B}{B_A}\right)}} dB = \int dt$$

$$\int \frac{dx}{ae^{kx} - be^{-kx}} = \frac{1}{2k \ln b} \log \left(\frac{\sqrt{ab} e^{kx} - b}{\sqrt{ab} e^{kx} + b} \right)$$

($ab > 0$) worked out by I.S. & verified in table of Integrals.

Here $k = \frac{1}{B_A}$

(*)

$$\frac{B_A (e - \frac{1}{e})}{2 \sqrt{(T_P - \frac{1}{e} T_A)(T_P - e T_A)}} \log \left[\frac{\sqrt{(T_P - \frac{1}{e} T_A)(T_P - e T_A)} e^{\left(\frac{B}{B_A}\right)} - (T_P - e T_A)}{\sqrt{(T_P - \frac{1}{e} T_A)(T_P - e T_A)} e^{\left(\frac{B}{B_A}\right)} + (T_P - e T_A)} \right] = t + C_0 \quad \text{by (*)} \\ t=0 \quad (B=0) \Rightarrow C_0 = \frac{B_A (e - \frac{1}{e})}{2 \sqrt{(T_P - \frac{1}{e} T_A)(T_P - e T_A)}} \log \left[\frac{\sqrt{(T_P - \frac{1}{e} T_A)(T_P - e T_A)} - (T_P - e T_A)}{\sqrt{(T_P - \frac{1}{e} T_A)(T_P - e T_A)} + (T_P - e T_A)} \right]$$

$$t = \frac{B_A (e - \frac{1}{e})}{2 \sqrt{(T_P - \frac{1}{e} T_A)(T_P - e T_A)}} \log \left[\frac{[\sqrt{(T_P - \frac{1}{e} T_A)(T_P - e T_A)} e^{\left(\frac{B}{B_A}\right)} - (T_P - e T_A)][\sqrt{(T_P - \frac{1}{e} T_A)(T_P - e T_A)} + (T_P - e T_A)]}{[\sqrt{(T_P - \frac{1}{e} T_A)(T_P - e T_A)} e^{\left(\frac{B}{B_A}\right)} + (T_P - e T_A)][\sqrt{(T_P - \frac{1}{e} T_A)(T_P - e T_A)} - (T_P - e T_A)]} \right]$$

(5)

$$\boxed{n=2} : \left[\begin{aligned} \frac{dB}{dt} = T &= T_A \cosh^2\left(\frac{\theta}{B_x}\right) + \left(\frac{T_p - T_A \cosh^2 1}{\sinh^2 1} \right) \sinh^2\left(\frac{\theta}{B_x}\right) \\ &= \left(\frac{e}{e^2-1} \right)^2 \left[(T_p - T_A) e^{\left(\frac{2\theta}{B_x}\right)} + (T_p - T_A) e^{\left(-\frac{2\theta}{B_x}\right)} + [T_A(e^2 + \frac{1}{e^2}) - 2T_p] \right] \end{aligned} \right] \quad T_p \geq T_A$$

$$\int \frac{dx}{ae^{kx} + ae^{-kx} + b} = \frac{2}{k\sqrt{4a^2 - b^2}} \tan^{-1} \left[\frac{2ae^{kx} + b}{\sqrt{4a^2 - b^2}} \right]$$

$$(ab > 0, \frac{b}{a} < 2)$$

$$\text{ie } 0 < \frac{b}{a} \leq 2$$

worked out by I.S. & verified in table of integrals.

$$\text{Here } k = \frac{2}{B_x}$$

(*)

$$\frac{(e - \frac{1}{e})^2}{[(T_p - T_A) e^{\left(\frac{2\theta}{B_x}\right)} + (T_p - T_A) e^{\left(-\frac{2\theta}{B_x}\right)} + [T_A(e^2 + \frac{1}{e^2}) - 2T_p]]} \frac{dB}{dt} = 1$$

$$\tan^{-1} x - \tan^{-1} y = \tan^{-1} \left(\frac{x-y}{1+xy} \right)$$

(*)

$$\int \frac{(e - \frac{1}{e})^2}{[(T_p - T_A) e^{\left(\frac{2\theta}{B_x}\right)} + (T_p - T_A) e^{\left(-\frac{2\theta}{B_x}\right)} + [T_A(e^2 + \frac{1}{e^2}) - 2T_p]]} dB = \int dt$$

$$\frac{B_x(e - \frac{1}{e})^2}{\sqrt{4(T_p - T_A)^2 - [T_A(e^2 + \frac{1}{e^2}) - 2T_p]^2}} \tan^{-1} \left[\frac{2(T_p - T_A) e^{\left(\frac{2\theta}{B_x}\right)} + [T_A(e^2 + \frac{1}{e^2}) - 2T_p]}{\sqrt{4(T_p - T_A)^2 - [T_A(e^2 + \frac{1}{e^2}) - 2T_p]^2}} \right] = t + c_0 \text{ by (*)}$$

$$t=0 \text{ (} \theta=0 \text{)} \Rightarrow c_0 = \frac{B_x(e - \frac{1}{e})^2}{\sqrt{4(T_p - T_A)^2 - [T_A(e^2 + \frac{1}{e^2}) - 2T_p]^2}} \tan^{-1} \left[\frac{T_A(e - \frac{1}{e})^2}{\sqrt{4(T_p - T_A)^2 - [T_A(e^2 + \frac{1}{e^2}) - 2T_p]^2}} \right]$$

$$t = \frac{B_x(e - \frac{1}{e})^2}{T_A \sqrt{4\left(\frac{T_p}{T_A}\right)(e - \frac{1}{e})^2 - (e^2 - \frac{1}{e^2})^2}} \tan^{-1} \left[\left(\frac{e}{e^2-1} \right) \left(\frac{e^{\left(\frac{2\theta}{B_x}\right)} - 1}{e^{\left(\frac{2\theta}{B_x}\right)} + 1} \right) \sqrt{4\left(\frac{T_p}{T_A}\right) - (e + \frac{1}{e})^2} \right]$$

by (*)

For $n \geq 2$ ($n \in \mathbb{N}$) the calculations become too cumbersome.

(6)

$$\boxed{\frac{dT}{dt} = c = \text{constant}}$$

see NOTE p. ⑩

Galileo Galilei + Simon Stevin.

$$\frac{dB}{dt} = T = T_A + ct \quad B = T_A t + \frac{1}{2} ct^2$$

(Newtonian Circumvention)

$$\frac{dT}{dt} = c \Rightarrow \frac{dT}{dB} \frac{dB}{dt} = c$$

$$\frac{dT}{dB} T = c$$

$$\frac{d}{dB} \left(\frac{T^2}{2} \right) = c$$

$$\frac{T^2}{2} = \frac{T_A^2}{2} + cB \Rightarrow c = \frac{T^2 - T_A^2}{2B} = \frac{T_P^2 - T_A^2}{2B_x} \quad (*)$$

$$\therefore T^2 = T_A^2 + (T_P^2 - T_A^2) \frac{B}{B_x}$$

$$\boxed{\frac{dB}{dt} = T = \sqrt{T_A^2 + (T_P^2 - T_A^2) \left(\frac{B}{B_x} \right)}}$$

$$\therefore \text{by } (*) \quad T = T_A + \left(\frac{T_P^2 - T_A^2}{2B_x} \right) t \quad B = T_A t + \left(\frac{T_P^2 - T_A^2}{4B_x} \right) t^2$$

$$\boxed{t = \frac{2B_x (T - T_A)}{(T_P^2 - T_A^2)} = \frac{2B_x}{(T_P^2 - T_A^2)} \left[\sqrt{T_A^2 + (T_P^2 - T_A^2) \left(\frac{B}{B_x} \right)} - T_A \right]}$$

$t = f(T) \qquad t = g(B)$

$$\text{Also } \left[T_A^2 + (T_P^2 - T_A^2) \left(\frac{B}{B_x} \right) \right]^{-\frac{1}{2}} \frac{dB}{dt} = 1 \Rightarrow \int \left[T_A^2 + (T_P^2 - T_A^2) \left(\frac{B}{B_x} \right) \right]^{-\frac{1}{2}} dB = \int dt$$

$$\Rightarrow \frac{2B_x}{(T_P^2 - T_A^2)} \sqrt{T_A^2 + (T_P^2 - T_A^2) \left(\frac{B}{B_x} \right)} = t + c_0 \quad t=0 (B=0) \Rightarrow c_0 = \frac{2T_A B_x}{T_P^2 - T_A^2}$$

$$\Rightarrow t = \frac{2B_x}{(T_P^2 - T_A^2)} \left(\sqrt{T_A^2 + (T_P^2 - T_A^2) \left(\frac{B}{B_x} \right)} - T_A \right) \quad \text{This immediately follows from } (*) \text{ also.}$$

⑨

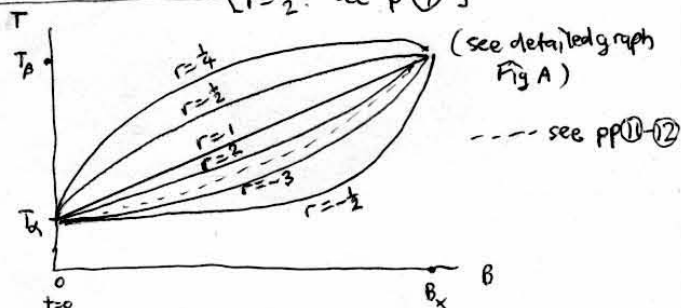
$$\frac{dB}{dt} = \Gamma = [T_A^{\frac{1}{r}} + (T_P^{\frac{1}{r}} - T_A^{\frac{1}{r}}) \left(\frac{B}{B_X}\right)^r] \quad r \in \mathbb{R} - \{0, 1\} \quad T_P \geq T_A$$

$r=0$: not defined.
 $r=1$: see p. ①
 $[r=\frac{1}{2}$: see p. ⑨]

$$[T_A^{\frac{1}{r}} + (T_P^{\frac{1}{r}} - T_A^{\frac{1}{r}}) \left(\frac{B}{B_X}\right)^r]^{-r} \frac{dB}{dt} = 1$$

$$\int [T_A^{\frac{1}{r}} + (T_P^{\frac{1}{r}} - T_A^{\frac{1}{r}}) \left(\frac{B}{B_X}\right)^r]^{-r} \frac{dB}{dt} dt = \int dt$$

$$\int [T_A^{\frac{1}{r}} + (T_P^{\frac{1}{r}} - T_A^{\frac{1}{r}}) \left(\frac{B}{B_X}\right)^r]^{-r} dB = \int dt$$



$$\frac{B_X}{(1-r)(T_P^{\frac{1}{r}} - T_A^{\frac{1}{r}})} [T_A^{\frac{1}{r}} + (T_P^{\frac{1}{r}} - T_A^{\frac{1}{r}}) \left(\frac{B}{B_X}\right)^r]^{(1-r)} = t + C_0$$

$$[T_A^{\frac{1}{r}} + (T_P^{\frac{1}{r}} - T_A^{\frac{1}{r}}) \left(\frac{B}{B_X}\right)^r]^{(1-r)} = \frac{(1-r)(T_P^{\frac{1}{r}} - T_A^{\frac{1}{r}})t}{B_X} + C_1 \quad t=0 (B=0) \Rightarrow C_1 = T_A^{(\frac{1}{r}-1)}$$

$$[T_A^{\frac{1}{r}} + (T_P^{\frac{1}{r}} - T_A^{\frac{1}{r}}) \left(\frac{B}{B_X}\right)^r]^{(1-r)} = \frac{(1-r)(T_P^{\frac{1}{r}} - T_A^{\frac{1}{r}})t}{B_X} + T_A^{(\frac{1}{r}-1)}$$

$$* \quad B = \frac{B_X}{(T_P^{\frac{1}{r}} - T_A^{\frac{1}{r}})} \left\{ \left[\frac{(1-r)(T_P^{\frac{1}{r}} - T_A^{\frac{1}{r}})t}{B_X} + T_A^{(\frac{1}{r}-1)} \right]^{(\frac{1}{1-r})} - T_A^{\frac{1}{r}} \right\}$$

$$* \Rightarrow T = \left[\frac{(1-r)(T_P^{\frac{1}{r}} - T_A^{\frac{1}{r}})t}{B_X} + T_A^{(\frac{1}{r}-1)} \right]^{(\frac{r}{1-r})} \quad \text{"Power accel." (accel. = } \frac{dT}{dt} \text{)}$$

$$= \frac{r(T_P^{\frac{1}{r}} - T_A^{\frac{1}{r}})}{B_X} \left[\frac{(1-r)(T_P^{\frac{1}{r}} - T_A^{\frac{1}{r}})t}{B_X} + T_A^{(\frac{1}{r}-1)} \right]^{(\frac{2r-1}{1-r})}$$

$$= \frac{r(T_P^{\frac{1}{r}} - T_A^{\frac{1}{r}})}{B_X} T^{(2-\frac{1}{r})}$$

$$** \Rightarrow t = \frac{B_X}{(1-r)(T_P^{\frac{1}{r}} - T_A^{\frac{1}{r}})} \left[T^{(\frac{1}{r}-1)} - T_A^{(\frac{1}{r}-1)} \right] = \frac{B_X}{(1-r)(T_P^{\frac{1}{r}} - T_A^{\frac{1}{r}})} \left\{ [T_A^{\frac{1}{r}} + (T_P^{\frac{1}{r}} - T_A^{\frac{1}{r}}) \left(\frac{B}{B_X}\right)^r]^{(1-r)} - T_A^{(\frac{1}{r}-1)} \right\}$$

$t = f(T) \qquad \qquad \qquad t = g(B)$

NOTE : The case $r=\frac{1}{2}$ corresponds to the formulae of p. ⑨ . ie. the case of "constant accel."

When $|r| \rightarrow \infty$ (ie. $r \rightarrow \pm\infty$) in the formula $T = [T_A^{\frac{1}{r}} + (T_P^{\frac{1}{r}} - T_A^{\frac{1}{r}})(\frac{B}{B_x})]^r$ of p. (10), the curves of the diagram on p. (10) converge (uniformly) to the curve marked ---- (see detailed graph Fig A). What is the formula for this curve?

Now $\lim_{|r| \rightarrow \infty} [T_A^{\frac{1}{r}} + (T_P^{\frac{1}{r}} - T_A^{\frac{1}{r}})(\frac{B}{B_x})]^r$

$$= \lim_{r \rightarrow \pm\infty} [T_A^{\frac{1}{r}} + (T_P^{\frac{1}{r}} - T_A^{\frac{1}{r}})(\frac{B}{B_x})]^r$$

$$= \lim_{r \rightarrow \pm\infty} \exp \left\{ r \log [T_A^{\frac{1}{r}} + (T_P^{\frac{1}{r}} - T_A^{\frac{1}{r}})(\frac{B}{B_x})] \right\}$$

$$= \exp \left\{ \lim_{r \rightarrow \pm\infty} r \log [T_A^{\frac{1}{r}} + (T_P^{\frac{1}{r}} - T_A^{\frac{1}{r}})(\frac{B}{B_x})] \right\} \quad \text{by the continuity of } f(x) = e^x.$$

$$= \exp \left\{ \lim_{r \rightarrow \pm\infty} \log [T_A^{\frac{1}{r}} + (T_P^{\frac{1}{r}} - T_A^{\frac{1}{r}})(\frac{B}{B_x})] / \frac{1}{r} \right\}$$

$$= \exp \left\{ \lim_{r \rightarrow 0} \log [T_A^{\frac{1}{r}} + (T_P^{\frac{1}{r}} - T_A^{\frac{1}{r}})(\frac{B}{B_x})] / r \right\}$$

$$= \exp \left\{ \lim_{r \rightarrow 0} \log [e^{r \log T_A} + (e^{r \log T_P} - e^{r \log T_A})(\frac{B}{B_x})] / r \right\}$$

$$= \exp \left\{ \lim_{r \rightarrow 0} \left[[T_A^{\frac{1}{r}} + (T_P^{\frac{1}{r}} - T_A^{\frac{1}{r}})(\frac{B}{B_x})]^{-1} \cdot [T_A^{\frac{1}{r}} \log T_A + (T_P^{\frac{1}{r}} \log T_P - T_A^{\frac{1}{r}} \log T_A)(\frac{B}{B_x})] / 1 \right] \right\}$$

by L'Hopital's rule and $\frac{d}{dx} a^x = \frac{d}{dx} e^{x \log a} = a^x \log a$.

$$= \exp \left\{ \left(\lim_{r \rightarrow 0} [T_A^{\frac{1}{r}} + (T_P^{\frac{1}{r}} - T_A^{\frac{1}{r}})(\frac{B}{B_x})]^{-1} \right) \left(\lim_{r \rightarrow 0} [T_A^{\frac{1}{r}} \log T_A + (T_P^{\frac{1}{r}} \log T_P - T_A^{\frac{1}{r}} \log T_A)(\frac{B}{B_x})] \right) \right\} \quad \text{by limit laws.}$$

$$= \exp \left\{ 1 \cdot [\log T_A + (\log T_P - \log T_A)(\frac{B}{B_x})] \right\}$$

$$= \exp \left\{ \log T_A + (\frac{B}{B_x}) \log (\frac{T_P}{T_A}) \right\}$$

$$= T_A \left(\frac{T_P}{T_A} \right)^{\frac{B}{B_x}} \quad (= T_A^{(1 - \frac{B}{B_x})} T_P^{\frac{B}{B_x}}).$$

So the curve marked ---- has the formula $T = T_A \left(\frac{T_P}{T_A} \right)^{\frac{B}{B_x}}$

See p. (12)

Note that this formula corresponds to the WELL-TEMPERED SCALE between T_A and T_P , divided into B_x equal tempo intervals. [Elliott Carter has used "well-tempered tempo glissandi". See PNM v.1 n.2 Spr. '63 p. 9-31 (p. 13-16) " v.3 n.2 Spr. '65 p. 47-57 (p. 53 fn. 13) (11)]

$$\boxed{\frac{dB}{dt} = T = T_A \left(\frac{T_P}{T_A} \right)^{\left(\frac{B}{B_x} \right)} \quad T_P \geq T_A}$$

See NOTE p. (13)

$$\frac{1}{T_A} \left(\frac{T_A}{T_P} \right)^{\left(\frac{B}{B_x} \right)} \frac{dB}{dt} = 1$$

$$\int \frac{1}{T_A} \left(\frac{T_A}{T_P} \right)^{\left(\frac{B}{B_x} \right)} \frac{dB}{dt} dt = \int dt$$

$$\int \frac{1}{T_A} \left(\frac{T_A}{T_P} \right)^{\left(\frac{B}{B_x} \right)} dB = \int dt$$

$$\frac{B_x}{T_A (\log T_A - \log T_P)} \left(\frac{T_A}{T_P} \right)^{\left(\frac{B}{B_x} \right)} = t + C_0 \text{ by } *$$

$$\left(\frac{T_A}{T_P} \right)^{\left(\frac{B}{B_x} \right)} = \frac{T_A (\log T_A - \log T_P) t}{B_x} + C_1, \quad t=0 (B=0) \Rightarrow C_1 = 1$$

$$\left(\frac{T_A}{T_P} \right)^{\left(\frac{B}{B_x} \right)} = \frac{T_A (\log T_A - \log T_P) t}{B_x} + 1$$

$$* \quad B = B_x \log \left[\frac{T_A (\log T_A - \log T_P) t}{B_x} + 1 \right] / (\log T_A - \log T_P)$$

$$* \Rightarrow \boxed{T = \frac{B_x T_A}{T_A (\log T_A - \log T_P) t + B_x}}$$

"Power accel." (accel. = $\frac{dT}{dt}$) = $\frac{B_x T_A^2 (\log T_P - \log T_A)}{[T_A (\log T_A - \log T_P) t + B_x]^2}$
 $= \left(\frac{\log T_P - \log T_A}{B_x} \right) T^2$

$$** \Rightarrow \boxed{t = \frac{B_x (T - T_A)}{T T_A (\log T_P - \log T_A)} = \frac{B_x}{T_A (\log T_P - \log T_A)} \left[1 - \left(\frac{T_A}{T_P} \right)^{\left(\frac{B}{B_x} \right)} \right]}$$

$t = f(T) \qquad \qquad \qquad t = g(B)$

NOTE : Due to the uniform convergence of the curves on p. (10), all of the above formulae could have been derived by taking $\lim_{|n| \rightarrow \infty}$ of the corresponding formulae on p. (10)!

This gives rise to another set of functions: $\frac{dB}{dt} = T = T_A \left(\frac{T_P}{T_A} \right)^{\left(\frac{B}{B_x} \right)^k} \quad T_P \geq T_A, k \geq 1.$

$$\frac{dB}{dT} = T = T_A \left(\frac{T_P}{T_A} \right) \left(\frac{B}{B_A} \right)^k \quad T_P \geq T_A, k \geq 1$$

(We choose $k \geq 1$, because for $0 < k < 1$, $\exists B_0 \in [0, B_A]$ such that $T_A \left(\frac{T_P}{T_A} \right) \left(\frac{B}{B_A} \right)^k \geq T_A + (T_P - T_A) \left(\frac{B}{B_A} \right)$ for all $B \in [0, B_0]$ — proof: consider $\frac{dB}{dT}$.)

$$\frac{1}{T_A} \left(\frac{T_P}{T_A} \right)^{-\left(\frac{B}{B_A}\right)^k} \frac{dB}{dT} = 1 \quad \leftarrow \text{2nd derivative.}$$

Now $\int \frac{1}{T_A} \left(\frac{T_P}{T_A} \right)^{-\left(\frac{B}{B_A}\right)^k} dB$ is not expressible as an elementary function for any $k > 1$, so we express it as an absolutely/uniformly convergent series approximating the solution to the required degree:

$$\frac{1}{T_A} \exp \left[-\left(\frac{B}{B_A} \right)^k \log \left(\frac{T_P}{T_A} \right) \right] \frac{dB}{dT} = 1$$

$$\frac{1}{T_A} \sum_{n=0}^{\infty} \left\{ \frac{(-1)^n}{n!} \left(\frac{B}{B_A} \right)^{nk} \left[\log \left(\frac{T_P}{T_A} \right) \right]^n \right\} \frac{dB}{dT} = 1 \quad \text{since } e^x = \sum_{n=0}^{\infty} \frac{x^n}{n!} \text{ for all } x. \text{ Both series converge uniformly.}$$

$$\int \frac{1}{T_A} \sum_{n=0}^{\infty} \left\{ \frac{(-1)^n}{n!} \left(\frac{B}{B_A} \right)^{nk} \left[\log \left(\frac{T_P}{T_A} \right) \right]^n \right\} \frac{dB}{dT} dT = \int dT$$

$$\int \frac{1}{T_A} \sum_{n=0}^{\infty} \left\{ \frac{(-1)^n}{n!} \left(\frac{B}{B_A} \right)^{nk} \left[\log \left(\frac{T_P}{T_A} \right) \right]^n \right\} dB = \int dT$$

$$\int_0^B \frac{1}{T_A} \sum_{n=0}^{\infty} \left\{ \frac{(-1)^n}{n!} \left(\frac{B}{B_A} \right)^{nk} \left[\log \left(\frac{T_P}{T_A} \right) \right]^n \right\} dB = \int_0^T dT$$

$$\frac{1}{T_A} \sum_{n=0}^{\infty} \left\{ \int_0^B \frac{(-1)^n}{n!} \left(\frac{B}{B_A} \right)^{nk} \left[\log \left(\frac{T_P}{T_A} \right) \right]^n dB \right\} = \int_0^T dT. \quad (\text{We can exchange } \sum_{n=0}^{\infty} \text{ and } \int_0^B \text{ due to the uniform convergence of the series.})$$

$$\frac{1}{T_A} \sum_{n=0}^{\infty} \left\{ \frac{(-1)^n \left[\log \left(\frac{T_P}{T_A} \right) \right]^n}{n! (nk+1) B_A^{nk}} B^{nk+1} \right\} = T. \quad \text{Put } f(B) = \sum_{n=0}^{\infty} \left\{ \frac{(-1)^n \left[\log \left(\frac{T_P}{T_A} \right) \right]^n}{n! (nk+1) B_A^{nk}} B^{nk+1} \right\}.$$

$$\text{Then } \left| f(B) - \sum_{n=0}^{s-1} \left\{ \frac{(-1)^n \left[\log \left(\frac{T_P}{T_A} \right) \right]^n}{n! (nk+1) B_A^{nk}} B^{nk+1} \right\} \right| \leq \frac{\left[\log \left(\frac{T_P}{T_A} \right) \right]^{s+1}}{s! (sk+1) B_A^{sk}} B^{sk+1} \quad \text{since the terms of the series decrease in magnitude and alternate in sign.}$$

$$\leq \frac{\left[\log \left(\frac{T_P}{T_A} \right) \right]^s}{(s+1)!} B_A^s \quad \text{for } B \in [0, B_A], k \geq 1.$$

NOTE: The case $k=1$ corresponds to the formulae of p. (12)

(13)

$$\text{Thus } \left| t - \frac{1}{T_A} \sum_{n=0}^{s-1} \left\{ \frac{(-1)^n [\log(\frac{T_B}{T_A})]^n}{n! (nk+1) B_x^{nk}} B^{nk+1} \right\} \right| \leq \frac{[\log(\frac{T_B}{T_A})]^s}{s! (s+1)!} B_x \text{ for } B \in [0, B_x], k \geq 1.$$

Now we wish to find t accurate to within $\frac{1}{2}$ sec. $\doteq 8.3 \times 10^{-3}$ mins; that is, for given T_A, T_B, B_x find

$$s \in \mathbb{N} \text{ such that } \frac{[\log(\frac{T_B}{T_A})]^s}{s! (s+1)!} B_x \leq 8.3 \times 10^{-3}. \text{ Then } \frac{1}{T_A} \sum_{n=0}^{s-1} \left\{ \frac{(-1)^n [\log(\frac{T_B}{T_A})]^n}{n! (nk+1) B_x^{nk}} B^{nk+1} \right\} = t \text{ to}$$

within $\frac{1}{2}$ sec. for all $B \in [0, B_x], k \geq 1$.

For $T_A = 43, T_B = 120, B_x = 196^*$ we have $s = 5$ in the above.

Thus:

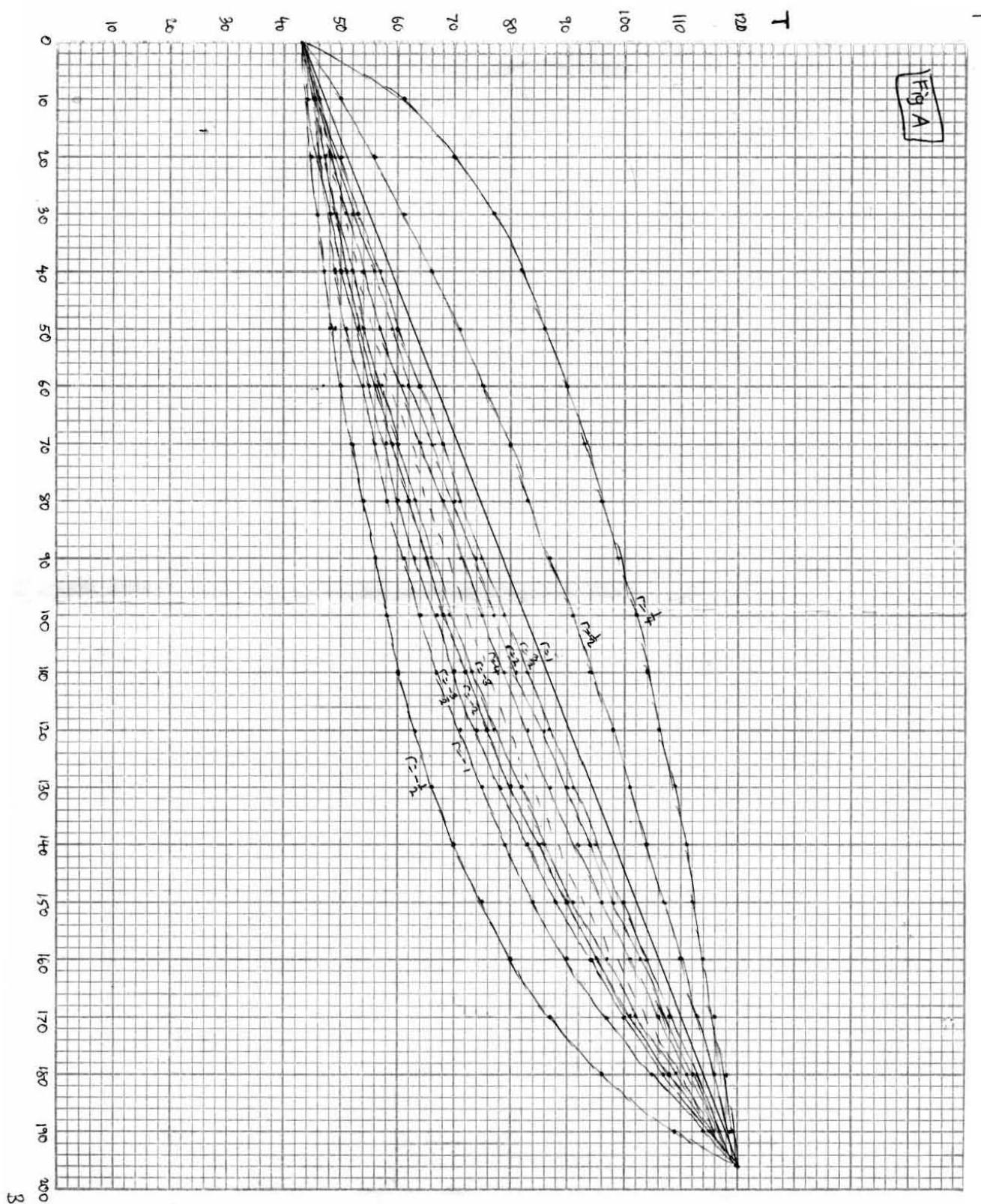
$$\text{For } T_A = 43, T_B = 120, B_x = 196 \text{ we have (to within } \frac{1}{2} \text{ sec.) for all } k \geq 1, 0 \leq B \leq 196:$$

$$t = \left\{ B - \frac{[\log(\frac{T_B}{T_A})]}{(k+1) B_x^k} B^{k+1} + \frac{[\log(\frac{T_B}{T_A})]^2}{2(2k+1) B_x^{2k}} B^{2k+1} - \frac{[\log(\frac{T_B}{T_A})]^3}{6(3k+1) B_x^{3k}} B^{3k+1} + \frac{[\log(\frac{T_B}{T_A})]^4}{24(4k+1) B_x^{4k}} B^{4k+1} \right\} \frac{1}{T_A}$$

Note that since the first term of the series to be omitted was negative, then because the terms of the series decrease in magnitude and alternate in sign, the above approximation will actually be greater than t (by no more than $\frac{1}{2}$ sec.). i.e.

$$t \leq \frac{1}{T_A} \sum_{n=0}^4 \left\{ \frac{(-1)^n [\log(\frac{T_B}{T_A})]^n}{n! (nk+1) B_x^{nk}} B^{nk+1} \right\} \leq t + 8.3 \times 10^{-3}.$$

* As in Echoes/Fantasies (1984)



2'28" to here.

time to B=106

Echoes/Fantasies (1984)

time from B=106 to B=196

total time

FORMULA

| | B | 0 | 13 | 25 | 36 $\frac{1}{2}$ | 45 $\frac{1}{2}$ | 57 $\frac{1}{2}$ | 68 $\frac{1}{2}$ | 80 | 94 | 106 | 119 | 131 | 142 $\frac{1}{2}$ | 151 $\frac{1}{2}$ | 163 $\frac{1}{2}$ | 174 $\frac{1}{2}$ | 186 | 196 | |
|---------|----|----|----|----|------------------|------------------|------------------|------------------|----|----|-----|-----|-----|-------------------|-------------------|-------------------|-------------------|------|-------|-------|
| (1) 43 | 48 | 53 | 57 | 61 | 66 | 70 | 74 | 80 | 85 | 90 | 94 | 99 | 103 | 107 | 112 | 116 | 120 | n=1 | p(1) | |
| (7) 43 | 43 | 44 | 46 | 47 | 50 | 52 | 56 | 61 | 66 | 71 | 77 | 84 | 89 | 97 | 104 | 112 | 120 | n=2 | p(2) | |
| (9) 43 | 43 | 43 | 43 | 44 | 46 | 46 | 48 | 51 | 55 | 60 | 66 | 73 | 79 | 88 | 97 | 109 | 120 | n=3 | p(3) | |
| (10) 43 | 43 | 43 | 43 | 43 | 44 | 44 | 45 | 47 | 50 | 53 | 58 | 65 | 70 | 80 | 91 | 105 | 120 | n=4 | p(4) | |
| (2) 43 | 46 | 49 | 52 | 55 | 58 | 62 | 66 | 71 | 75 | 81 | 86 | 91 | 95 | 102 | 107 | 114 | 120 | n=1 | p(5) | |
| (8) 43 | 43 | 44 | 45 | 46 | 48 | 50 | 53 | 57 | 61 | 66 | 72 | 78 | 83 | 92 | 100 | 110 | 120 | n=2 | p(6) | |
| (3) 43 | 47 | 51 | 55 | 59 | 63 | 67 | 71 | 77 | 81 | 87 | 92 | 96 | 100 | 106 | 110 | 115 | 120 | r=3 | p(7) | |
| (9) 43 | 47 | 51 | 54 | 57 | 62 | 66 | 70 | 75 | 80 | 85 | 90 | 95 | 99 | 105 | 110 | 115 | 120 | r=2 | p(8) | |
| (4) 43 | 47 | 50 | 54 | 56 | 60 | 64 | 68 | 73 | 78 | 84 | 89 | 94 | 98 | 104 | 109 | 115 | 120 | r=3 | p(9) | |
| (4) 43 | 46 | 50 | 53 | 56 | 60 | 63 | 68 | 73 | 77 | 83 | 88 | 93 | 97 | 103 | 109 | 115 | 120 | r=4 | p(10) | |
| (2) 43 | 46 | 50 | 53 | 55 | 59 | 63 | 67 | 72 | 77 | 82 | 87 | 92 | 96 | 102 | 108 | 114 | 120 | r=6 | p(11) | |
| (2) 43 | 46 | 49 | 51 | 54 | 57 | 60 | 64 | 69 | 73 | 79 | 84 | 89 | 94 | 100 | 106 | 113 | 120 | r=6 | p(12) | |
| (2) 43 | 46 | 48 | 51 | 53 | 57 | 60 | 63 | 68 | 72 | 78 | 83 | 88 | 93 | 99 | 106 | 113 | 120 | r=4 | p(13) | |
| (5) 43 | 46 | 48 | 51 | 53 | 56 | 59 | 63 | 67 | 72 | 77 | 82 | 87 | 92 | 99 | 105 | 113 | 120 | r=3 | p(14) | |
| (5) 43 | 45 | 48 | 50 | 52 | 55 | 58 | 62 | 66 | 70 | 75 | 80 | 86 | 90 | 97 | 104 | 112 | 120 | r=2 | p(15) | |
| (5) 43 | 45 | 47 | 50 | 52 | 54 | 57 | 60 | 65 | 69 | 74 | 79 | 84 | 89 | 96 | 103 | 112 | 120 | r=3 | p(16) | |
| (6) 43 | 45 | 47 | 49 | 51 | 53 | 55 | 58 | 62 | 66 | 70 | 75 | 81 | 85 | 93 | 100 | 110 | 120 | r=1 | p(17) | |
| (6) 43 | 45 | 46 | 48 | 50 | 52 | 54 | 56 | 60 | 63 | 68 | 72 | 77 | 82 | 89 | 97 | 108 | 120 | r=3 | p(18) | |
| (2) 43 | 46 | 49 | 52 | 55 | 58 | 62 | 65 | 70 | 75 | 80 | 85 | 91 | 95 | 101 | 107 | 114 | 120 | k=1 | p(19) | |
| (6) 43 | 44 | 45 | 47 | 48 | 51 | 53 | 56 | 60 | 65 | 70 | 75 | 81 | 86 | 94 | 102 | 111 | 120 | k=3 | p(20) | |
| (8) 43 | 43 | 44 | 45 | 45 | 47 | 49 | 51 | 54 | 58 | 63 | 68 | 74 | 79 | 88 | 97 | 108 | 120 | k=2 | p(21) | |
| (9) 43 | 43 | 43 | 44 | 44 | 45 | 46 | 48 | 51 | 54 | 58 | 63 | 68 | 74 | 83 | 93 | 106 | 120 | k=5 | p(22) | |
| (10) 43 | 43 | 43 | 43 | 44 | 44 | 45 | 46 | 48 | 51 | 54 | 58 | 64 | 69 | 78 | 89 | 103 | 120 | k=3 | p(23) | |
| (11) 43 | 43 | 43 | 43 | 43 | 44 | 44 | 45 | 47 | 48 | 51 | 55 | 60 | 65 | 74 | 85 | 101 | 120 | k=7 | p(24) | |
| (11) 43 | 43 | 43 | 43 | 43 | 43 | 44 | 44 | 45 | 47 | 49 | 53 | 57 | 62 | 71 | 82 | 99 | 120 | k=4 | p(25) | |
| (12) 43 | 43 | 43 | 43 | 43 | 43 | 43 | 44 | 45 | 46 | 48 | 51 | 55 | 59 | 68 | 79 | 97 | 120 | k=2 | p(26) | |
| (12) 43 | 43 | 43 | 43 | 43 | 43 | 43 | 44 | 44 | 45 | 47 | 49 | 53 | 57 | 65 | 76 | 95 | 120 | k=5 | p(27) | |
| (13) 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 44 | 45 | 46 | 48 | 51 | 55 | 63 | 74 | 93 | 120 | k=11 | p(28) |
| (14) 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 44 | 44 | 45 | 47 | 50 | 54 | 61 | 72 | 91 | 120 | k=6 | p(29) |
| (14) 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 44 | 45 | 46 | 49 | 52 | 59 | 70 | 89 | 120 | k=13 | p(30) | |



The University of Sydney

Faculty of Arts

Old Teachers' College, A22
New South Wales 2006
Australia

Reference: M Try
SID: 8050967

Ian Leslie Shanahan
57 Yates Avenue
Dundas Valley
NSW 2117

Tuesday, 3 June 2003

Dear Mr Shanahan,

Degree Doctor of Philosophy

Department Music, J09

The reports of the examiners of your thesis have now been considered. I am pleased to be able to tell you that you have qualified for the award of the degree subject to your making typographical corrections to the satisfaction of the Head of the Department of Music.

In order to assist you, copies of the examiners' reports are enclosed. The corrections are to be made in the copy of the thesis which is to be deposited in Fisher Library. Copies of your thesis which were submitted for examination are now at the Faculty office. You should collect these and then consult with your Supervisor or with the Head of your Department, who will advise you about the corrections required.

Please note that the corrections should be completed within one month of the date of this letter.

The corrected thesis, for submission to the Faculty, should be permanently-bound, printed on acid-free or permanent paper, and returned to the Head of the Department. After I have been advised in writing by the Head of the Department that the corrections have been made satisfactorily, and the corrected thesis has been submitted to the Faculty, I will write to you further about the conferral of your degree.

Yours sincerely

for
Professor Stephen Garton
Dean of the Faculty of Arts

encl Notification card

cc Head of Dept (Attn: Postgraduate Co-ordinator)
Supervisor
Sequence
File



The University of Sydney

Degree of Doctor of Philosophy Examiner's report on thesis

Report Due 25 July 2002

Professor Brian Ferneyhough
Stanford University

Name of Examiner and Institution

Name of candidate **Shanahan, Ian Leslie**

Faculty/College **Arts**

SID **8050967**

Date of submission **20 March 2002**

Title of thesis

**A World of Becoming: Eleven Original
Compositions, with Analytical Notes, by Ian
Shanahan.**

1. Recommendation

Please initial the
appropriate boxes

After examination of the thesis and supporting papers, I recommend that:

(a) Award

the candidate be awarded the degree of Doctor of Philosophy without further examination; ☒

or (b) Award subject to typographical corrections

the candidate be awarded the degree of Doctor of Philosophy subject to correcting typographical errors before the degree is conferred. (Typographical errors include spelling, grammar, punctuation, capitalisation and reference dates) ☐

or (c) Award subject to conditions

the candidate be awarded the degree of Doctor of Philosophy subject to conditions listed elsewhere in this report being addressed to the satisfaction of the University.

These are (i) the making of minor emendations¹ ☐

and/or (ii) the fulfilment of other conditions² ☐

or (d) Revision and Re-examination

the candidate be not awarded the degree of Doctor of Philosophy, but be permitted to resubmit the thesis in a revised form for re-examination following a further period of study³. The errors or deficiencies in my opinion substantially affect the argument or the thesis ☐

I feel a further period of research extending over months would also be necessary..... ☐

or (e) Non-Award

the candidate not be awarded the degree of Doctor of Philosophy ☐

2. Opinion

I report that in my opinion

(a) the thesis is a substantially original contribution to the knowledge of the subject concerned ☒

(b) the thesis affords evidence of originality by the discovery of new facts ☒

(c) the thesis affords evidence of originality by the exercising of independent critical ability ☒

(d) the thesis is satisfactory as regards literary presentation ☒

(e) a substantial amount of material in the thesis is suitable for publication ☒

3. Release to the candidate of examiner's name and comments

I agree to the release to the candidate, when the examination is complete,

(a) of my comments (in whole or in the parts designated) ☒

(b) of my name ☒

Notwithstanding your wishes, the University may be required, in some circumstances, to release this information.

Examiner **Brian Ferneyhough**

Date **31.5.02**

4. Grounds for recommendation (see overleaf)

Notes

1. Minor emendations are the correction of errors or the addition or deletion of material in the text, tables of figures, or appendices of a minor nature throughout the thesis. More substantial emendations within one chapter which do not require a return to examiners, but can be adjudicated by the Head of Department or School fall into this category. Changes as substantial as the addition or re-writing of a whole chapter would normally be considered a revision not emendations.

2. You may wish to recommend other conditions the candidate should fulfil, such as some form of further examination. In the latter case, please advise on the form of such examination. Please note that the University does not normally require a candidate to undertake a viva voce examination.

3. Revision and resubmission requires re-examination. Please indicate whether you would be willing to re-examine a revised thesis if so invited.

☐ Yes ☒ No

4. The University permits theses to be submitted for examination in a temporary binding. The degree will not, however, be awarded until at least one copy of the thesis, containing any emendations or corrections that may be required, is bound in permanent form.

Examiner's report continued

4. Grounds for recommendation

Please state the grounds on which you base your recommendation. Examiners are not always unanimous in their recommendations and so a decision must be made about the award of the degree on the basis of these reports. Indicate, where appropriate, the strengths and weaknesses of the thesis and the particular contributions made by the candidate. If suggesting emendations, please list them in the report rather than writing them in the margin of the thesis. Attach additional information on a separate sheet if required.

March '98

Please see separate sheets already submitted.

Signed

[Signature]

Date

31.5.03

Prof. Brian Ferneyhough,
William H. Bonsall Professor in Music
Stanford University

In his introduction to Ursprung des deutschen Trauerspiels Walter Benjamin asserts that the principal object of regard of philosophy is necessarily the concept of reproduction. In that spirit, the Pythagoreans might be said to have colluded in a particularly rigorous and ritualistic form of practical 're-production' or Mimesis, in that number and ratio are deployed in a wide-reaching attempt to array all phenomena and epiphenomena in a mantle of over-arching metaphor. Quite how much this proto-Idealist poetics of rationality is credibly to be invoked today is an open question. Certainly, the symbolic value of numerological calculation can be encountered in many productions of the poetic spirit in all periods of artistic practice, whether in a spirit of playful autochthony (qua the OULIPO group in France) or in a more directly mystical evocation of the ineffable oneness of spirit and life-world as exemplified by much of Karlheinz Stockhausen's recent compositional activity. Where – and, indeed, if – the boundary separating useful intellectual analogy and more powerful and problematic assertions of 'universal laws' is crossed can of course be argued from case to case; I thus have no issue with the present dissertation text if it is taken as a record of one individual's exigent traversal of a wide variety of intellectual/historical constructs. We all take our inspiration where we can find it. My concern resides far more in what seem to be assertions of the global validity of certain modes of perception and cognition which remain slippery and elusive at best, refracted, as they are, through whatever theoretical distorting lens seems most opportune. I am concerned that little distinction is made between high-level mathematical procedures (which I personally am unqualified to comment on) and concepts (such as that of the Epicycle in Renaissance astronomy) which, in the last resort, are little more than temporary patches on the suppurating wound of imprecision which chronically plagued pre-Copernican models of the universe. One is inescapably reminded of those savant philosopher-theologian proponents of universal syncretist wisdom such as John Dee, Robert Fludde and Paracelsus, whose vast compendia sought to bring together Jewish mysticism, rediscovered ancient Greek philosophy and Christian theology in a final convulsive burgeoning of natural magic as a bulwark against the first subversive inroads of scientific method. I personally am very drawn to the tragic grandeur of these encyclopaedic ruins, and accept that works of art, together with their engendering discourses of cultural legitimisation, share much with them on a local ideological level. I am disturbed in this case, not by such obvious affinities, but by an intellectual virtuosity

seeking to validate its poietic practice in and through the mass accumulation of disciplines and part-disciplines as instantiations of canonic authority, especially given the fact that the only unifying meta-discourse offered is that of the work realisations themselves – a strategy tantamount to a grandiose essay in the strategic application of circular argument as a model of self-authentication.

But no matter: ultimately, it is the music work which must provide the justification for such consistent inconsistency. I will thus turn now to a discussion of the submitted compositions themselves, examined not as more or less efficacious particularisations of current or historical generalities, but as entities in and through which particular forms of aesthetic cognition may be said to open sensually mediated perspective on possible worlds.

I take as my initial object Cycles of Vega. Whilst the preceding works in the volume have their individual charms, I feel that they are rather too slight to offer conclusive commentary. In Cycles, however, several of the composer's most attractive aspects are immediately on display – in particular, his inventiveness in the realm of percussion and his striking capability for enveloping the Eb clarinet protagonist in a web of secondary sonorities. Mr Shanahan has obviously spent considerable time and thought on the many and varied means by which this has been accomplished. The larger form of the piece is difficult to discern, but the unbroken sequence of striking local eruptions more than compensates the focused listener in that regard. Percussion instruments run the risk of being perceived rather as 'things' than as measured and integrated components of a larger sonic field: in this particular composition this danger is convincingly bypassed, firstly by the very variety and overlapping envelopes of the instruments employed, secondly by the notable fragility and alienated habitus of the clarinet, whose material is never permitted to establish itself as any form of 'authority.' Mr Shanahan's approach to the whole ensemble is notably fastidious; his textural world – whatever its theoretical grounding – transmits a lively sense of organic interplay which is unaffectedly convincing.

The other work I wish to mention is the flute solo work Dimensiones Paradisi. Aligning itself in the by now somewhat lengthy tradition of 'extended techniques' flute diction, it nevertheless succeeds in adding to the depth of that lineage by dint of its deep sense of fidelity to 'fluteness'. An interesting ancillary aspect of the notational specificity employed is the ease with which Mr Shanahan moves between rhythmically precise constellations and various degrees of more texturally open dimensional representation. Normally, I am suspicious of works which resort to such diversity of iconicity, since I believe that notation controls invention, not vice versa. In this instance, though, I was mildly surprised and gratified to observe the almost seamless juxtaposition of elements

containing extremes of rhythmic precision and circumambient moments of irregular, 'naturalistic' flow. The full spectrum of techniques is included, without this plenitude being sensed as in some way forced upon the ear as a prime raison d'être. The governing image in this extended meditation is surely that of breath, sensed both in subtly modulated air sounds and lengthy sustained pitches alleviated by precise internal microtonal fluctuation.

Mr. Shanahan is clearly in possession of a differentiated and entirely adequate compositional handwork. It would be interesting to examine other works by this artist with a view to confirming or disconfirming a sense of disquiet regarding stylistic consistency and profile. Perhaps that is not an issue that concerns Mr Shanahan, however, given that the internal identity of each work is clearly established.

Be that as it may, Mr Shanahan's present submission is clearly worthy of the degree sought. I recommend its acceptance.

Sincerely Yours

A handwritten signature in black ink, appearing to read 'Brian Ferneyhough'. The signature is fluid and cursive, with a large, stylized 'F' and a long, sweeping underline.

Brian Ferneyhough



The University of Sydney

Report Due 25 July 2002

Professor Brian Fernyhough Prof. G. Hair
Stanford University

Degree of Doctor of Philosophy Examiner's report on thesis

Name of Examiner and Institution

Name of candidate **Shanahan, Ian Leslie**

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1. Recommendation

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appropriate boxes

(a) Award

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or (b) Award subject to typographical corrections

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the candidate be awarded the degree of Doctor of Philosophy subject to conditions listed elsewhere in this report being addressed to the satisfaction of the University. ☐

These are (i) the making of minor emendations¹ ☐

and/or (ii) the fulfilment of other conditions² ☐

or (d) Revision and Re-examination

the candidate be not awarded the degree of Doctor of Philosophy, but be permitted to resubmit the thesis in a revised form for re-examination following a further period of study³. The errors or deficiencies in my opinion substantially affect the argument or the thesis ☐

I feel a further period of research extending over months would also be necessary. ☐

or (e) Non-Award

the candidate not be awarded the degree of Doctor of Philosophy ☐

2. Opinion

I report that in my opinion

(a) the thesis is a substantially original contribution to the knowledge of the subject concerned ☐

(b) the thesis affords evidence of originality by the discovery of new facts ☐

(c) the thesis affords evidence of originality by the exercising of independent critical ability ☐

(d) the thesis is satisfactory as regards literary presentation ☐

(e) a substantial amount of material in the thesis is suitable for publication ☐

3. Release to the candidate of examiner's name and comments

I agree to the release to the candidate, when the examination is complete,

(a) of my comments (in whole or in the parts designated) ☒ **GH**

(b) of my name ☒ **GH**

Notwithstanding your wishes, the University may be required, in some circumstances, to release this information.

Examiner **Graham Hair** Date **19/11/2002**

4. Grounds for recommendation (See overleaf)

Notes

1. Minor emendations are the correction of errors or the addition or deletion of material in the text, tables of figures, or appendices of a minor nature throughout the thesis. More substantial emendations within one chapter which do not require a return to examiners, but can be adjudicated by the Head of Department or School fall into this category. Changes as substantial as the addition or re-writing of a whole chapter would normally be considered a revision not emendations.

2. You may wish to recommend other conditions the candidate should fulfil, such as some form of further examination. In the latter case, please advise on the form of such examination. Please note that the University does not normally require a candidate to undertake a viva voce examination.

3. Revision and resubmission requires re-examination. Please indicate whether you would be willing to re-examine a revised thesis if so invited. ☐ Yes ☐ No

4. The University permits theses to be submitted for examination in a temporary binding. The degree will not, however, be awarded until at least one copy of the thesis, containing any emendations or corrections that may be required, is bound in permanent form.

Examiner's report continued

4. Grounds for recommendation

Please state the grounds on which you base your recommendation. Examiners are not always unanimous in their recommendations and so a decision must be made about the award of the degree on the basis of these reports. Indicate, where appropriate, the strengths and weaknesses of the thesis and the particular contributions made by the candidate. If suggesting emendations, please list them in the report rather than writing them in the margin of the thesis. Attach additional information on a separate sheet if required.

March '98

Three pages follow. *Graham Hair*

Signed

Graham Hair

Date

19/11/2002

A World of Becoming is a summation of a decade (plus) of creative work, in which the whole panoply of the author's compositional concerns are laid out, rather than a dissertation directed towards a close critical examination of a specific, well-defined problem which fills in lacunae in the state of current knowledge: a personal compositional intellectual geography, with quite a strong element of autobiography about it. Since I express below a degree of scepticism about some of the assertions in the commentary, I should clarify straight away that I construe the commentary as a secondary part of the total document – whose purpose is to illuminate the compositions – rather than a piece of critical thought capable of standing alone. That said, I have no hesitation in stating that in my view the competitions presented here (as embodied in the scores and the performances of them) show a level of original thought, creative imagination and technical competence worthy of the award of the PhD, and I am happy to recommend at the outset of this report that the dissertation be accepted for the degree without further amendment.

There is an integrity, and an intensity of compositional passion about the compositions included in *A World of Becoming* which I found wholly admirable. Amongst lots of evidence for this, we might begin with the degree of commitment to realisation of a creative vision through sheer macropaedic thoroughness and the way in which complicated practical problems are confronted rather than merely explained away. The dissertation constitutes (in passing) what amounts almost to an encyclopaedia of various experimental musical vocabularies (from the very abstract, eg generalised permutational procedures, to the utterly concrete, eg fingering patterns and the like).

Moreover, this portfolio of work extends and maps new aesthetic and practical territory in respect of instruments such as mandolin and recorder with a panache and originality equal to just about anything I know of. (The treatments of piano and electro-acoustic media seem not quite up to this standard of idiomatic surefootedness). Mr Shanahan claims that his use of techniques related to those of the recent trend to compositional 'complexity' (in the specific, narrow, technical sense of that term) enabled him to integrate into the textural and formal fabric of these scores what was previously a rather haphazard treatment of 'extended' instrumental techniques in some of his earlier compositions, and this seems to me a claim which the scores themselves bear out, and I certainly found this aspect of his work convincing. Nevertheless, for me, the most satisfying piece overall was the piece for E-flat clarinet and percussion (*Cycles of Vega*), for structural as much as sonic reasons. On the larger architectural level: although such means as the secret cyphers (1.15), systematic permutation (1.17), formal self-similarity on the macro-, meso- and micro-level (1.55), Fibonacci and Lucas series (1.121) are materials which by now are approaching venerable old age [though perhaps not so much e, pi, root 2, root 3 (1.122) ?], they do seem genuinely appropriate means of achieving the flexible treatment of temporal and textural patterning which appears to be a driving force in these works, and I don't know of too many composers who have been able to integrate geometric durational patterns and tempo glissandi into a his repertoire of compositional procedures more successfully than Mr Shanahan in this portfolio.

Actually, Mr Shanahan seems unnecessarily defensive about his independence from 'complexism', because overall there is remarkably little evidence of such connections in the compositions themselves, though the commentary wheels out a few stereotypical 'complexist' attitudes: "systemic pitch-edifices alone seem to me to be incapable of

elucidating any but the most prosaic of foregrounds ..." and so on (was there ever anyone who thought otherwise? – cf my comments below on overly-local contextualisation). In fact, to my ears, there is more to recall an earlier generation of 'Old Modernism' (Webern, Cage, Feldman et al) than of 'complexism' in the sound of these pieces which, for the most part (the piano piece perhaps excepted) give evidence of a finely-honed and delicate aural sensibility, despite the more up-to-date notational practices.

To the extent that I have criticisms to offer of this work, they relate more to the context Mr Shanahan claims for his music, than to the specifics of individual compositions; nevertheless, these things are not without consequences for his work. Without going so far as Adorno's assertion that every composer must contain a critic (which seems to assume that critical thought would lead all composers to agree with the author of the opinion), may I mention in passing 3 or 4 issues which stem from the polemical tone of much of Mr Shanahan's commentary, and from the observation that his contextualisation is sometimes based on assumptions of a rather local nature, which are (at the very least) problematical under a broader historical view.

To take a real simple example: I think Mr Shanahan over-estimates the capacity of the non-standard mixed ensemble to produce the sonic freshness which he craves. In 'The Refractory Masterpiece' (on Schoenberg's op 9), in *Constructive Dissonance* (ed Brand & Hailey 1997), Walter Frisch shows that the role of chamber music as a vehicle for 'private' musical vision has a 100-year history (culminating in the mixed ensemble particularly characteristic of post-war 'avant-garde' chamber work), which has produced its own repertoire of stereotypical formal conventions concerning procedures, gestural vocabularies and aesthetics. Indeed, *A World of Becoming* contains instances where the author is not averse to dealing with conventions conventionally, eg his avowed passion for bell-sounds and typical bell-like gestures within FM synthesis and other sonic environments (Programme annotations to *Anturus Timespace*). More generally: I wasn't entirely convinced that the occasionally hermetic quality of Mr Shanahan's writing doesn't have something to do with this particular prejudice.

I was fascinated by Mr Shanahan's invocation of various ancient and modern writers, artists and theologians of platonist orientation, not least because it's a literature in which I share an interest, because these references never seem pretentious or *ex cathedra*, and because there is indeed a genuinely lofty and contemplative quality about his music which seems sustained by this background.

Nevertheless, I am rather sceptical that 'MAS' ('multilevel architectonic similarity', to employ the abstract's nomenclature) necessarily 'reconciles seemingly heterogeneous forms into a unified whole' and even more sceptical about the idea of characterising the compositional outcomes of 'MAS' with adjectives such as 'lifelike' or by means of analogies with the complexity of the natural order (another idea with a long genealogy). The order of analogy involved seems to me simply too glib to stand close scrutiny as a 'grand narrative'. Nevertheless, Mr Shanahan does indeed demonstrate its efficaciousness in handling certain specific concrete problems (cf my remarks above on 'extended' instrumental techniques).

I mention this problem of technical and aesthetic levels because of another respect in which Mr Shanahan seems unnecessarily defensive, viz the 'inaudibility' of his various numerological structures etc. His quote from Jonathan Kramer on Stravinsky's *Algon* (1.119)

GH

"The pervasiveness of one proportional ratio is the key to the unity that is not apparent on the work's surface" (1.119) does seem to invoke precedent, but the immediately-following assertion is that "Such close approximations [within 2.7%] are surely well within the limits of perception." (1.120), and Kramer moves on (further on in the same article, not quoted by Mr Shanahan) to note and to imply ways in which complex structures may indeed lead to audible results (the doubling of values every 4th series-member, etc).

Music theory has a long history of dealing with the relationship between audibility and inaudibility in a sophisticated way. (The concept of audibility invoked by Schenker's *Urlinien*, for example, is not so straightforward). Mr Shanahan's armoury of techniques raises equally interesting and complicated questions about the relationship between production and reception (compositional technique and perception), and it would have been interesting to read him broaching some of them. However, in an age when critical theory has long since recognised the rhetoricality of all discourse, his commentary on the virtue of 'imperceptible' numerology reads rather like an old-fashioned *ex cathedra* statement reminding us just how much modernist and postmodernist patterns of polemic resemble one another.

Indeed there's a strain of historical determinism running through the commentary (of the "all history leads to where I am" kind), an approach with a long historical pedigree (cf Schoenberg et al) to be sure, but modern critical theory has long since deconstructed this line of argument, and the virtues of Mr Shanahan's portfolio are evident enough without it, so I wondered why he thought it necessary. It leads inevitably to the concomitant of this deterministic line, viz the 'straw man' critique of postmodernism (characterising what you want to demolish in such obviously simplistic terms that even the most limited intellect can 'blow it over'), which pervades the first and last sections of Mr Shanahan's discourse. "I despise banality and blandness" (1.13) and "crassness, clichéd pastiche, superficiality, things quotidian, unintelligence, a lack of 'soul', technical incompetence, unimaginativeness, and (dare I say it) downright stupidity" (1.13). Who doesn't, modernist or postmodernist? Notwithstanding such polemic, the definition of the composer's task as that of constructing a specific artefact which presents an individual solution to a problem within parameters set by pre-defined limitations is widespread amongst many traditional musicians and cultures as well as postmodernists. Leo Treitler once suggested the act of composition is more akin to that of inventor than that of discoverer, and even if Mr Shanahan doesn't agree, it's not only postmodernists who think so.

Graham Hair



Degree of Doctor of Philosophy

Examiner's report on thesis

Name of Examiner and Institution

Name of candidate **Shanahan, Ian Leslie**Faculty/College **Arts**SID **8050967**Date of submission **20 March 2002**

Title of thesis

A World of Becoming: Eleven Original Compositions, with Analytical Notes, by Ian Shanahan.

1. Recommendation

After examination of the thesis and supporting papers, I recommend that:

Please initial the appropriate boxes

(a) **Award**

the candidate be awarded the degree of Doctor of Philosophy without further examination; ☐

or (b) **Award subject to typographical corrections**

the candidate be awarded the degree of Doctor of Philosophy subject to correcting typographical errors before the degree is conferred. (Typographical errors include spelling, grammar, punctuation, capitalisation and reference dates) ☒

or (c) **Award subject to conditions**

the candidate be awarded the degree of Doctor of Philosophy subject to conditions listed elsewhere in this report being addressed to the satisfaction of the University.

These are (i) the making of minor emendations¹ ☐and/or (ii) the fulfilment of other conditions² ☐

or (d) **Revision and Re-examination**

the candidate be not awarded the degree of Doctor of Philosophy, but be permitted to resubmit the thesis in a revised form for re-examination following a further period of study³. The errors or deficiencies in my opinion substantially affect the argument or the thesis ☐I feel a further period of research extending over months would also be necessary ☐

or (e) **Non-Award**

the candidate not be awarded the degree of Doctor of Philosophy ☐

2. Opinion

I report that in my opinion

(a) the thesis is a substantially original contribution to the knowledge of the subject concerned ☒(b) the thesis affords evidence of originality by the discovery of new facts ☐(c) the thesis affords evidence of originality by the exercising of independent critical ability ☒(d) the thesis is satisfactory as regards literary presentation ☒(e) a substantial amount of material in the thesis is suitable for publication ☒

3. Release to the candidate of examiner's name and comments

I agree to the release to the candidate, when the examination is complete,

(a) of my comments (in whole or in the parts designated) ☒(b) of my name ☐

Notwithstanding your wishes, the University may be required, in some circumstances, to release this information.

Examiner Date **30th July 2002**

4. Grounds for recommendation (See overleaf)

Notes

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3. Revision and resubmission requires re-examination. Please indicate whether you would be willing to re-examine a revised thesis if so invited. ☐ Yes ☐ No

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March '98

See attached sheets

Signed

Date 30/7/2002

Comments on the thesis of Ian Leslie Shanahan

These comments may be released to the candidate.

Overall

I consider that my main rôle as examiner of this thesis is to comment on the mathematical aspects of the thesis, and the relationship of the mathematics to the music. I do this below.

Nonetheless, I would like to comment on the music as music. The thesis presents a significant body of work, realising a distinct, and distinctive, personal vision. I found the music inspiring, particularly in its concern to link the human and cosmic aspects of existence. The percussion outburst in *153 Infinities* representing the voice(s) of God is extraordinary.

Some comments on structural elements in the music. At the highest structural level, Mr Shanahan's use of long-range cyclic repetition and systematic arrangements of permutations generally results in music which has a sense of "eternal stasis, of glacial timelessness..." (page 1.28). Though this is not the case for every composition: in the discussion of *Solar Dust*, Mr Shanahan states that "Notions of tension and release are then imposed on the work as a whole..." (page 2.3.2). It is also stated that *Arcturus Timespace* and *Cycles of Vega* show that cyclic timelessness can coexist with linear time-directness.

At structural levels below the highest there is evidently a great deal of freedom; this is very far from algorithmic composition. Equally, I am sure it is true that the systems Mr Shanahan constructs allow him to obtain results that would be very difficult to reach by purely intuitive composition.

It is clear also that the pieces are not simply exercises in structure; if this were the case, timbre would be unimportant, but it clearly plays a big rôle in these compositions, at the level of actual sound, and at a symbolic level.

The analysis is illuminating and the relationship of the music with mathematics is very interesting.

I recommend that the degree be awarded, subject to the very minor corrections listed under "Presentation" below.

Presentation

The thesis is meticulously presented, with almost no typographical errors, which is remarkable in a work of this size and complexity. There are some comments on the presentation of the mathematics later on; I am not calling for any changes in the mathematics.

I noted the following errors:

Page 1.2.5, 6th line from the bottom:

replace “straticulated” by another word, probably “stratified”.

- ✓ Score of *Arcturus Timespace*, p. vi, under the heading “Bitones”:
there is a missing full stop and closing bracket after “finger”.
- ✓ Score of *Arcturus Timespace*, p. vi, under the heading “Bitones”, last line:
replace “this bitones” by “this bitone”.
- ✓ Page 5.1.6, footnote (‡):
replace “layed” by “laid”. ✓ Also T.O.C. 2.1 title.

Mr Shanahan’s fondness for unusual vocabulary has led him astray in one case. According to the Oxford English Dictionary, “straticulate” is an adjective, not a verb, and so “straticulated” is an illegitimate formation. In the context it appears to be an attempt to create a needless synonym for “stratified”; possibly “staggered” was meant.

The mathematics

These are my comments on the mathematics in the thesis and its relationship to the music.

The mathematics in the thesis is correct and is in general well explained. The notation employed is somewhat non-standard, and at times clumsy, but this appears to be due to the exigencies of the word-processing software used. On page 1.55, the formula $n \times n+1$ has to be interpreted as $n \times (n + 1)$, or, in a more common notation, $n(n + 1)$, and the formula $n \times n+1 \times n+1$ has to be interpreted as $n(n + 1)(n + 1)$. As a consequence, in a formula like

$$a_1 = (2 \times \mathcal{A}_n - n \times n - 1 \times t) \div (2 \times n),$$

which occurs on page 1.111, the second minus sign only operates on the two symbols (namely n and 1) immediately adjacent to it, while the first minus sign operates on the compound expressions $2 \times \mathcal{A}_n$ and $n \times n - 1 \times t$.

It is clear from Appendix 9 that Mr Shanahan is familiar with the usual notational conventions.

The notation $T^{-1}(T)$ on page 1.132 is unfortunate, since T is used for both a function and a particular value. This could have been avoided by choosing a different letter (say U) for the function which returns the tempo after a given number of elapsed beats.

I would like to distinguish three uses of mathematics in the thesis.

Mathematics in the solution of technical problems

The first use of mathematics I distinguish in the thesis is its application to solve specific technical problems. The only example worked out in the thesis is the satisfactory solution in section 1.2.12 of the problem of the distribution of intermediate tempi in prolonged “tempo-glissandi” of specified forms. I would not be surprised to find that Mr Shanahan had also applied mathematical methods to solve other technical problems arising in the composition of the music presented; for example the calculation of parameters to achieve desired frequencies in FM sound synthesis.

Mathematics as a means of structuring compositions

The second use of mathematics in the thesis is as a means for structuring compositions, and this is the major use of mathematics in the thesis. I distinguish this from the first use because there is no specific technical problem to be solved, but rather an aesthetic problem which is at best vaguely specified.

Here the mathematical apparatus is less formidable and more flexible than may at first appear. As an example, consider the permutations of 18 objects occurring in *Zodiac: Crystal Orbit Improvisations*, as discussed on page 1.22 of the thesis. A specific permutation ∂ is introduced (incidentally, a strange notation); the cyclic group generated by ∂ is found to contain 60 permutations, and all 60 are used in the composition. So far, so systematic. But in fact a second operation, “rotation”, is introduced and applied irregularly. This “rotation” is justified by reference to Stravinsky’s serial composition, but mathematically it corresponds to the introduction of another permutation:

$$(1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18)$$

in the notation of the thesis. Thus Mr Shanahan is arguably working in the group generated by ∂ and this new permutation. The resulting group is not cyclic, and is in fact the full symmetric group on 18 objects. (There is no particular significance in this; I am informed that two permutations chosen at random are quite likely to generate the full symmetric group.) Thus Mr Shanahan could justify using any permutation whatever in the composition.

Mr Shanahan is also working in a group larger than his starting cyclic group when he introduces the “subpermutations” of the permutation θ in *Cycles of Vega* (page 1.31). In Chapter 9, he announces his intention to explore groups more general than cyclic ones; it seems the process has already started.

In addition, within his general frameworks, Mr Shanahan has allowed himself many possibilities for selection and rearrangement (even without considering “symmetry-breaking”.) To give just one example, in *Lines of Light* a permutation μ is introduced. The cyclic group generated by μ contains μ itself and in addition μ^2 , μ^3 , μ^4 and μ^5 . On page 1.65 there is a table showing the use of these permutations. Their distribution is quite irregular: μ occurs once, μ^3 occurs three times and μ^2 does not occur at all. Since no reason is given for this irregularity, presumably it simply indicates free compositional choice, even at this structural level. (Though there is always the possibility that a systematic process has been applied and that Mr Shanahan is concealing some compositional arcanum here.)

I note that Mr Shanahan makes extensive use of systematic structures for duration (or rhythm) and distribution of timbres, but comments that he finds “systemic pitch-edifices” unsatisfactory. It would have been interesting to hear more on this.

Mathematics as a metaphor

The third use of mathematics in the thesis is harder to describe, but could be labelled “metaphoric” or “analogical” (in the ordinary sense, not the specific sense of page 1.3 of the thesis). If God is a pure mathematician (Sir James Jeans) then music which reflects the cosmic order will have a mathematical structure. Thus in *Cycles of Vega* the epicyclic structure is, in the words of the programme note, a “processional metaphor” and a “vibrant

model of the cosmos it extols” (“model” in the ordinary sense, rather than in the sense of a mathematical model). The epicycles in *Cycles of Vega* are not derived from the actual motions of the bodies in the solar system (or even from the ancient attempts to represent these motions); rather the mathematical structures in *Cycles of Vega* form an analogical representation of the structural complexities of the Cosmos.

This third use of mathematics shades into the second use considered above, but I distinguish them, because it is certainly possible to structure a composition mathematically without having cosmic (or any other) analogies in mind.

The analogical representation of specific scientific or mathematical concepts can be problematic. I would like to discuss the term “symmetry breaking” as used in Section 1.2.5 of the thesis. This term has an ordinary general meaning, but a specific scientific meaning is referred to in the thesis. This scientific meaning arises from an apparently paradoxical situation, where an effect is less symmetric than its cause. The explanation, in my understanding (which is consistent with the discussion in the thesis), goes as follows. There is an initial highly symmetric situation, but small random disturbances are also present. The initial situation is (or becomes) unstable, so under the influence of the small disturbances the system evolves away from the initial situation towards a less symmetric, but stable, state.

As an example, consider the vibration of the clarinet reed discussed in the thesis (page 1.71). The initial state of the reed is immobility. Thus the reed is in the same position at all times: its position is completely symmetric with respect to time. This static position is unstable, and the reed starts to move, small irregularities in the player’s otherwise steady airflow causing the system to evolve away from the initial state. The reed settles in to a periodic vibration, which is a stable state, though less symmetric with respect to time than the original stasis.

The point I wish to make is that symmetry-breaking, in this specific sense, has several essential elements. There is a *highly symmetric initial state*, *small disturbances* (typically very small) are present, the initial state is *unstable*, and the system evolves to another state which is *less symmetric* but is *stable*.

The question which arises is: how many of these elements need to be present in an analogical form, if a musical composition is to be described as representing symmetry-breaking in the specific sense. In *Dimensiones Paradisi* there are arguably enough elements present to justify the use of the term. There is an elaborate symmetric plan arising from the “sacred geometry”, we can imagine that the small deviations from this symmetric represent small disturbances in some sense, and the combination of the original structure with the 24 interjections could be regarded as the new, less symmetric structure.

Nonetheless, I found the apparent identification of symmetry-breaking with any “disruption of process” (page 1.72) to be perilously close to meaningless scientific name-dropping.

There is a further aspect of symmetry-breaking which is mentioned in the thesis, and that is the “choice” by the system of one alternative out of many. Suppose that in the clarinet reed example, the reed settles down to an oscillation of 100 cycles per second. If we look at the motion over an interval of $1/100$ of a second, there will be one peak excursion of the reed. It could occur at any time in the interval, but it must occur at some specific

time, which the system “chooses”. The idea that a realised composition is an asymmetric fragment of a larger symmetric whole which exists only *in potentia* is intriguing, and, as indicated in the final chapter of the thesis, is coming to play a significant part in Mr Shanahan’s thinking.

Sources of inspiration

On the evidence of the thesis, Mr Shanahan draws his inspiration from two main areas: one area comprises modern physics and modern mathematics, and the other area includes *gematria*, sacred geometry, and Christian and occult symbolism. These two areas, or worlds of thought, had a common mathematical base (very roughly, the mathematics of Euclid’s *Elements*), but have now become antithetical. A mystic might hope for a future reunion of the two, but as yet there is no sign of that, either in reality or in the thesis.

I have no wish to legislate the sources of a composer’s inspiration, and I can see one powerful attraction of sacred geometry and the like: they provide, or purport to provide, a direct link between the human and the Divine, something modern mathematics and physics fails to do. Furthermore such a link is evidently vital for, and a great strength of, Mr Shanahan’s compositions.

Nonetheless I find it jarring when the two worlds of thought collide, as they do in *Lines of Light*. I found the collision particularly jarring in footnote (*) of page 1.60, which derives approximations to $\sqrt{2}$, $\sqrt{3}$, and the Golden Section constant ϕ from the wavelengths of the most prominent Fraunhofer lines. (Incidentally, Mr Shanahan omitted the B line at approximately 6875 Å from his calculations.) What is jarring about Mr Shanahan’s numerology here is the fact that spectral lines are close to manifestations of pure number in any case, as they arise from electron orbital numbers, and indeed it seems that the clue to the Bohr atom was number patterns in the wavelengths of the spectral lines of the hydrogen atom.

I do not want these comments to be taken as too negative. The work presented in the thesis raises interesting and important questions about the ways mathematics relates to music, and, especially through the extended examples of the compositions and associated analyses, makes a significant contribution to the discussion of these questions.